Bell Telephone Quarterly

VOL. XIII JANUARY, 1934 No. 1

EXHIBITING TELEPHONE PROGRESS
AT THE WORLD'S FAIR

SYSTEMS OF LONG TELEPHONE LINES

THE ROLE OF DROP WIRE

COMMUNICATION WITH ELECTRICAL BRAINS

A CENSUS PORTRAYAL OF THE
AMERICAN FAMILY

American Telephone & Telegraph Co. • New York

Bell Telephone Quarterly

VOLUME XIII, 1934

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BELL TELEPHONE QUARTERLY

VOLUME XIII, 1934

TABLE OF CONTENTS

JANUARY, 1934

Exhibiting Telephone Progress at the World's Fair, by *C. T. Smith* 3
Systems of Long Telephone Lines, by *J. J. Pilliod* 23
The Rôle of Drop Wire, by *R. A. Haislip* 36
Communication with Electrical Brains, by *John Mills* 47
A Census Portrayal of the American Family, by *R. L. Tomblen* 58

APRIL, 1934

Network Broadcasting
I. Historical Summary, by *R. T. Barrett* 75
II. Operating the Networks, by *E. V. Wallace* 98
III. Telephone Facilities, by *G. S. Bibbins* 106
Teamwork at Anderson, Indiana, by *Vance Oathout* 113
Owners of the Bell System, by *C. S. Van Cise* 128
International Radio Telephone Circuits, by *Elam Miller* 142
Notes on Recent Occurrences 150

JULY, 1934

Meeting an Emergency at Birmingham, Alabama, by *F. M. Craft* 155
Conference Telephone Service, by *Helene C. Bateman* 176
World's Telephone Statistics, by *C. J. Koukol* 188
Adventures in Communication, by *J. O. Perrine* 200

OCTOBER, 1934

The Telephone Problem in the World's Largest Metropolitan Area, by *Kirtland A. Wilson* 233
Buying by Telephone at Department Stores, by *J. M. Shaw* 267
Telephone Power Plants, by *G. L. Weller* 289
The International Telephone Conferences of 1934, by *H. E. Shreeve and H. S. Osborne* 303
Significant Changes in the Occupational Distribution of the American Population, by *R. L. Tomblen* 309
Notes on Recent Occurrences 327

BELL TELEPHONE QUARTERLY

VOLUME XIII, 1934

INDEX

PAGE

Adventures in Communication, by J. O. Perrine 200
Anderson, Indiana, Teamwork at, by Vance Oathout 113

Barrett, R. T.: Historical Summary, Part I—Network Broadcasting 75
Bateman, Helene C.: Conference Telephone Service 176
Bell, J. F., Elected a Director, Note on 327
Bibbins, G. S.: Telephone Facilities, Part III—Network Broadcasting 106
Birmingham, Alabama, Meeting an Emergency at, by F. M. Craft 155
Broadcasting, Network
I. Historical Summary, by R. T. Barrett 75
II. Operating the Networks, by E. V. Wallace 98
III. Telephone Facilities, by G. S. Bibbins 106
Buying by Telephone at Department Stores, by J. M. Shaw 267

Census Portrayal of the American Family, A, by R. L. Tomblen 58
Circuits, International Radio Telephone, by Elam Miller 142
Communication, Adventures in, by J. O. Perrine 200
Communication with Electrical Brains, by John Mills 47
Conference of Bell System Public Relations Officials, Note on 327
Conference Telephone Service, by Helene C. Bateman 176
Craft, F. M.: Meeting an Emergency at Birmingham, Alabama 155

Direct Radio Telephone Circuit Links United States and Java, Note on 150
Drop Wire, The Rôle of, by R. A. Haislip 36

Electrical Brains, Communication with, by John Mills 47
Exhibiting Telephone Progress at the World's Fair, by C. T. Smith 3

Family, A Census Portrayal of the American, by R. L. Tomblen 58

Haislip, R. A.: The Rôle of Drop Wire 36

International Radio Telephone Circuits, by Elam Miller 142
International Telephone Conferences of 1934, by H. E. Shreeve and H. S. Osborne 303

Java, Direct Radio Telephone Circuit Links United States and, Note on 150
Jewett, Frank B., Elected a Trustee of Carnegie Institution, Note on 151

Koukol, C. J.: World's Telephone Statistics 188

PAGE

Meeting an Emergency at Birmingham, Alabama, by F. M. Craft 155
Metropolitan Area, The Telephone Problem in the World's Largest, by Kirtland A. Wilson 233
Miller, Elam: International Radio Telephone Circuits 142
Mills, John: Communication with Electrical Brains 47
Mills, John: "Signals and Speech in Electrical Communication," Note on 151

Network Broadcasting
I. Historical Summary, by R. T. Barrett 75
II. Operating the Networks, by E. V. Wallace 98
III. Telephone Facilities, by G. S. Bibbins 106

Oathout, Vance: Teamwork at Anderson, Indiana 113
Occupational Distribution of the American Population, Significant Changes in the, by R. L. Tomblen 309
Osborne, H. S. and H. E. Shreeve: International Telephone Conferences of 1934 303
Owners of the Bell System, by C. S. Van Cise 128

Perrine, J. O.: Adventures in Communication 200
Pilliod, J. J.: Systems of Long Telephone Lines 23
Population, Significant Changes in the Occupational Distribution of the American, by R. L. Tomblen 309
Power Plants, Telephone, by G. L. Weller 289
Public Relations Officials, Conference of Bell System, Note on 327

Radio Telephone Circuit, Direct, Links United States and Java, Note on 150
Radio Telephone Circuits, International, by Elam Miller 142
Rôle of Drop Wire, The, by R. A. Haislip 36

Shaw, J. M.: Buying by Telephone at Department Stores 267
Shreeve, H. E. and H. S. Osborne: International Telephone Conferences of 1934 303
"Signals and Speech in Electrical Communication," by John Mills, Note on 151
Significant Changes in the Occupational Distribution of the American Population, by R. L. Tomblen 309
Smith, C. T.: Exhibiting Telephone Progress at the World's Fair 3
Systems of Long Telephone Lines, by J. J. Pilliod 23

Teamwork at Anderson, Indiana, by Vance Oathout 113
Telephone, Buying by, at Department Stores, by J. M. Shaw 267
Telephone, International, Conferences of 1934, by H. E. Shreeve and H. S. Osborne 303
Telephone Circuits, International Radio, by Elam Miller 142
Telephone Lines, Long, Systems of, by J. J. Pilliod 23
Telephone Power Plants, by G. L. Weller 289
Telephone Problem in the World's Largest Metropolitan Area, The, by Kirtland A. Wilson 233
Telephone Progress at the World's Fair, Exhibiting, by C. T. Smith 3
Telephone Service, Conference, by Helene C. Bateman 176
Telephone Statistics, World's, by C. J. Koukol 188

PAGE

Tomblen, R. L.: A Census Portrayal of the American Family 58
Tomblen, R. L.: Significant Changes in the Occupational Distribution of the American Population 309

Van Cise, C. S.: Owners of the Bell System 128

Wallace, E. V.: Operating the Networks, Part II—Network Broadcasting 98
Weller, G. L.: Telephone Power Plants 289
Wilson, Kirtland A.: The Telephone Problem in the World's Largest Metropolitan Area 233
World's Fair, Exhibiting Telephone Progress at the, by C. T. Smith 3
World's Telephone Statistics, by C. J. Koukol 188

BELL TELEPHONE QUARTERLY

A Medium of Suggestion and a Record of Progress

CONTENTS FOR JANUARY 1934

PAGE

Exhibiting Telephone Progress at the World's Fair—*C. T. Smith* . . . 3

Systems of Long Telephone Lines—*J. J. Pilliod* 23

The Rôle of Drop Wire—*R. A. Haislip* 36

Communication with Electrical Brains—*John Mills* 47

A Census Portrayal of the American Family—*R. L. Tomblen* 58

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Address all communications to

INFORMATION DEPARTMENT
AMERICAN TELEPHONE AND TELEGRAPH COMPANY
195 Broadway, New York

CONTRIBUTORS TO THIS ISSUE

C. THEODORE SMITH

University of North Carolina, B.S. in Electrical Engineering, 1927; Harvard Graduate School of Business Administration, M.B.A., 1929. American Telephone and Telegraph Company, Chief Statistician's Division, 1929–.

J. J. PILLIOD

Ohio Northern University, E.E., 1908. American Telephone and Telegraph Company, Long Lines Department, 1908–1911; General Engineering Department, 1912–1913; Long Lines Department, Division Plant Engineer, 1914–1917, Engineer of Transmission, 1918–1919, Engineer, 1920–.

R. A. HAISLIP

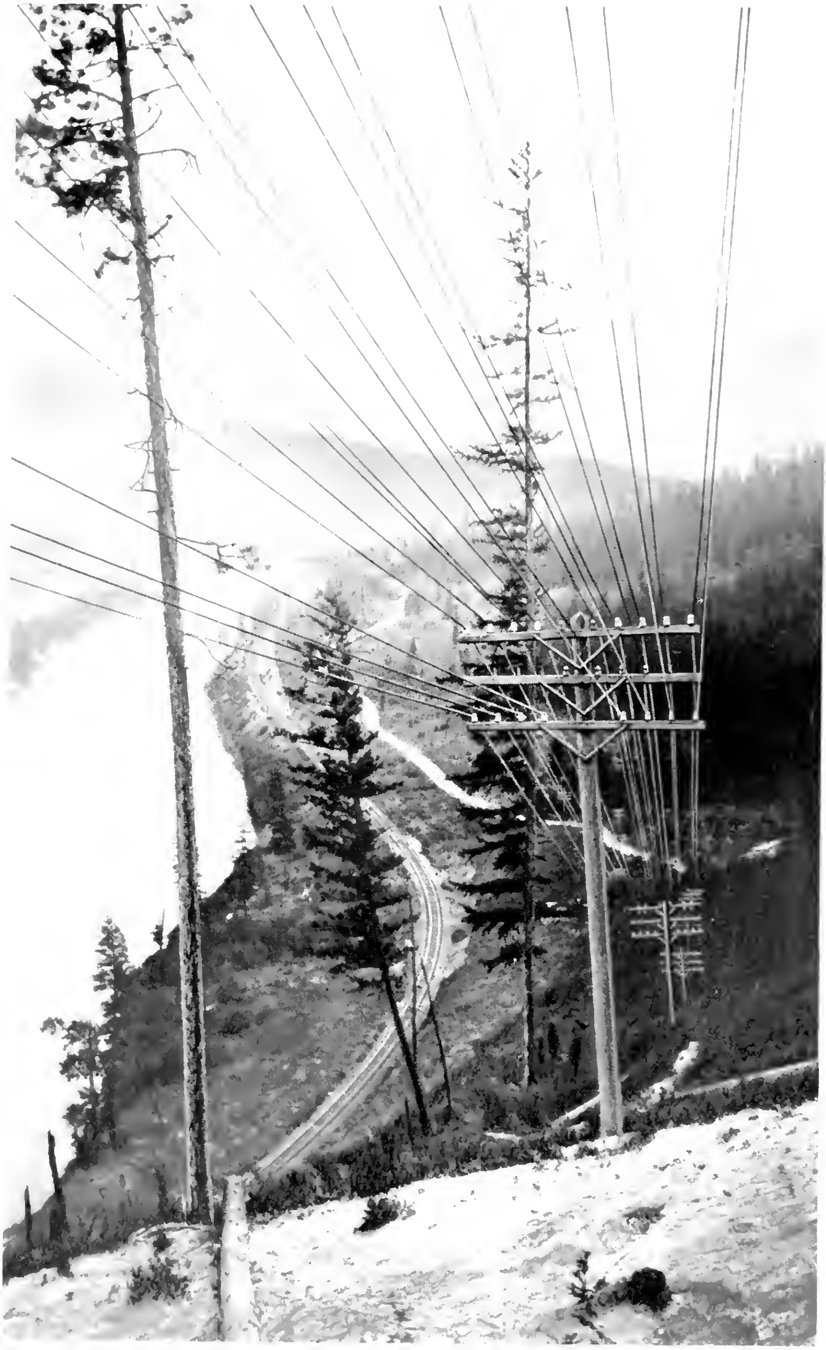
Virginia Polytechnic Institute, 1904. Testman, Central District and Printing Telegraph Co., Pittsburgh (now Bell Telephone Company of Pennsylvania), 1904–1906. Engineer, Pacific Telephone and Telegraph Company, 1906–1910. Chief Engineer, British Columbia Telephone Co., 1910–1912. American Telephone and Telegraph Company, General Engineering Department, 1912–1919; Department of Development and Research, engineer and Assistant Outside Plant Development Engineer, 1919–1932, Outside Plant Development Engineer, 1932–.

JOHN MILLS

University of Chicago, B.A., 1901; Massachusetts Institute of Technology, B.S., 1909. American Telephone and Telegraph Company, General Engineering Department, 1911–1915. Western Electric Company, Research Department, 1915–1921; Engineering Department, 1921–1925. Bell Telephone Laboratories, Director of Publication, 1925–.

ROBERT L. TOMBLEN

Bates College, B.A., 1914; Worcester Polytechnic Institute, B.S., 1917. American Telephone and Telegraph Company, Department of Operation and Engineering, Commercial Engineer's Division, 1919–1929; Chief Statistician's Division, 1929–.



SECTION OF TELEPHONE LINE IN WESTERN MONTANA

This is Part of a Line from Minneapolis to Seattle, Which is One Link in the System of Long Telephone Routes in the United States Described in the Article "Systems of Long Telephone Lines" in This Issue.

Exhibiting Telephone Progress at the World's Fair

THROUGHOUT the entire period of the World's Fair, the telephone exhibit proved to be one of the most popular and most talked of features at A Century of Progress Exposition in Chicago. Judging from the large crowds which the exhibit attracted, the animated interest which the visitors displayed, and the widespread favorable comment which the demonstrations stimulated, there can be little doubt that the telephone exhibit was a highly successful public relations undertaking, both for the Bell System and for the telephone industry as a whole. Millions of people throughout the country have a better understanding of the telephone service which they take so much as a matter of course, and a new realization of the important part which the human element plays in rendering that service.

The broad concept underlying the Chicago Exposition is signified in the name: A Century of Progress. The past one hundred years have witnessed tremendous advancement in man's knowledge of the forces of nature, and the application of that knowledge in industry has resulted in profound changes in the everyday life of millions of individuals. It was this story of scientific discovery which was unfolded to the millions of World's Fair visitors in simple and living terms designed to give the individual without technical background or engineering training a better understanding of the scientific forces which, in large measure, have shaped the course of his daily life. One of the most vital chapters in this story of scientific achievement is the development of the art of telephone communication. Certainly in no other field of scientific endeavor has progress been more rapid; in few have the social consequences been more far-reaching.

The purpose of the telephone exhibit was to give the public a fuller knowledge of telephone service and of the operations and equipment involved in providing that service, and to impress upon the visitor something of the institutional character of the Bell System. These objectives and the "progress" concept of the Exposition, together with the consideration that the demonstrations should be of general public interest, were fundamental in the selection of material for presentation at the World's Fair. Accordingly, there were included on the second floor of Communications Hall, which was devoted entirely to Bell exhibits, demonstrations of long distance service, the dial telephone, "scrambled speech," multi-channel telegraphy, four typical switchboard operations, and one of the latest developments of transmission research whereby sound is reproduced in full auditory perspective. Plans for these exhibits had been laid sufficiently far in advance of the Fair to permit the development of special apparatus and equipment by Bell Telephone Laboratory experts, and the construction of an especially designed building which provided ample space and made possible an exhibition hall possessing a unity and a dignity which were most impressive. Moreover, every exhibit was a unit in itself and so placed with reference to aisle space as to receive maximum attention from the attending throngs. Areas devoted to the demonstration of local and long distance commercial services were located directly below on the first floor, and institutional displays and the executive headquarters of the exhibit were to be found in two of the towers outside, forming a part of Communications Court.

As readers of the BELL TELEPHONE QUARTERLY know from a previous article,[1] the general arrangements for the Bell System exhibit were under the guidance of Vice-presidents F. B. Jewett

[1] "The Bell System Exhibit at the Century of Progress Exposition," by John Mills; BELL TELEPHONE QUARTERLY, January 1933.

and A. W. Page of the American Telephone and Telegraph Company. From the inception of the general idea, however, Mr. John Mills of the Bell Telephone Laboratories' staff was in charge of all architectural and technical details, assisted by Mr. M. B. Long, also of the Laboratories' staff. The history of the exhibit, in fact, is in two long and interesting divisions—the arduous and exacting period of preparation which extended over two years and the period of operation and demonstration.

The Bell System demonstrations were not in any sense designed to be museum pieces or automatic displays of telephone service, but were intended to stress the common factor in all telephone service and the moving spirit behind all progress in the communications art—the human element in the business. This tremendously potent factor was recognized and provided for at the Bell System exhibit. All the demonstrations, in so far as possible, were personalized and, furthermore, were designed for active public participation. As evidence that this personalized method of demonstrating created a real impression on the public are the hundreds of enthusiastic letters which were received during the course of the summer and the thousands of favorable comments made at the exhibit itself.

Attesting to the popularity and appeal of the telephone exhibit at A Century of Progress Exposition is the fact that, from the opening of the Fair on May 27 until its close on November 12, attendance at the exhibit totaled 6,350,000 persons. Making allowances for "repeaters" on the basis of sampling studies, at least 5,000,000 different individuals came to the Bell System exhibit and caught something of the message which that exhibit conveyed. These visitors came from every State in the Union and represented all ages and every social and economic level. On the average, about one out of every four persons entering the Fair grounds each day visited the exhibit, and at least three out of four saw the telephone demonstration on one of the days they visited the Exposition.

Communications Hall, which was a part of the Electrical Group of buildings, was located at about the center of the island directly across from the Hall of Science. It connected with the mainland through the Hall of Social Science over the 16th Street bridge and with the Federal and States groups of buildings over a viaduct. Facing the lagoon on one side and Lake Michigan on the other, the Hall was one of the most ideally located buildings on the Exposition grounds and caught the main flow of traffic on the island. There were some eight main entrances to the telephone exhibit space, and two inside stairways connecting the first and second floor areas. The northern entrance on the second floor, however, proved to be by far the most popular; about half of the total attendance reached the exhibit through that portal.

On entering the second floor of the telephone exhibit, one of the first things which attracted the attention of the visitor was a large crowd around the balcony rail, some seated listening with earphones to the performance on a sound proof stage across the way and others standing behind the seats waiting their turn at the receivers. This performance was the demonstration of Acoustical Illusions, or the "Oscar Show" as it was popularly called, because of Oscar, the "Dummy with Microphone Ears," who played an important part in the performance. About 4,500,000 persons stopped to observe the show and close to 600,000 actually heard the demonstration. With space available for only 30 sets of receivers, it was physically impossible to accommodate all who desired to listen.

Since this was the first time that this demonstration had been publicly presented in the form used at the Fair, considerable experimentation was necessary to develop the most effective technique of presentation. As finally worked out, a large part of the show was put on with the stage curtains closed; the remarks of the demonstrators were addressed to "Oscar" rather than to the listeners as an audience. The show itself usually lasted for a period of six or seven minutes,

Figure 1. A General View of the Electrical Group of Exhibition Buildings, Showing the Four Towers Surrounding Communications Court.

Figure 2. A General View of a Portion of the Second Floor Area of the Telephone Exhibit from the Northern Entrance.

FIGURE 3. THE STAGE OF THE "OSCAR" DEMONSTRATION.

FIGURE 4. LISTENING TO THE "OSCAR" DEMONSTRATION.

with an interval of about a minute between performances. It started with the opening of the curtains on the sound proof stage for the purpose of attracting the attention of the listeners. At this point they were told to be sure to keep a receiver to each ear; that if they shared earphones they would find themselves, in effect, deaf in one ear.

Following these preliminary instructions, the curtains were closed and most of the illusions were put on with the demonstrator out of sight of his audience. A voice would say, "Well, I guess I'll go down and put some coal on the fire," or "It's time to go up on the roof and feed the pigeons." Immediately after, the sound of a closing door could be heard; apparently the demonstrator had left the stage. For a moment it would be silent, and then a voice whispered directly into the left ear of the listener, "I beg your pardon, did you drop this?"; and then perhaps in the right ear, "Would you move over, please. I can't see a thing." Many of the listeners on hearing a voice, apparently of someone standing behind them, would look around to see who was speaking. Later, a loud "Boo" brought instantaneous reactions on the part of the listeners in the form of startled exclamations and much laughter. The actions and amused expressions on the faces of the listeners throughout the performance testified to their enjoyment and to the reality of the illusions which were being conveyed. All of their spontaneous movements in response to what they heard mystified and provided much entertainment for the spectators without earphones, standing behind the seats.

At the end of this part of the performance the curtains were again opened and a brief explanation of the demonstration was given, which went something along this line: "This show, ladies and gentlemen, is a demonstration of one of the developments of the research laboratories of the Telephone Company which are constantly striving to improve the quality of telephone transmission. You noticed that all the sounds made here on the stage—from the highest to the lowest note and from the faintest whisper to the loudest noise—were faithfully reproduced in the receivers you are using. You noticed also that you could actually locate the direction from which these sounds came. The secret of the show is my silent partner here, Oscar, the Dummy. Oscar has a microphone in his left ear which is connected directly to the receiver which you hold to your left ear; in his right ear is another microphone which connects to the receiver at your right ear. Thus, when I am at Oscar's right the microphone on that side picks up the sounds and conveys them to you just as Oscar hears them. When I am at Oscar's left, the microphone in his left ear picks up the sounds and you hear them just as he does."

The demonstration of long distance telephony was one of the most popular features of the telephone exhibit. It was designed to demonstrate the speed with which long distance calls are completed, the operations involved in establishing connections, the high quality of transmission, and the national range of the service. Visitors were offered the opportunity of participating in this demonstration by making personal calls over the regular long distance lines. This feature of the telephone exhibit became very widely known during the course of the summer and the one question which the Bell exhibit attendants were called upon to answer more frequently than any other was, "Will you please tell me where to make a free Long Distance call?" Almost invariably the World's Fair guides, in conducting parties through the exhibit, would call attention to the large map of the United States which was visible from all parts of the second floor area and explain that souvenir long distance calls could be made to any one of 55 cities in the country. Many of the conductors on the transportation buses in the Grounds, in announcing the Communications Hall stop, would say, "This is the place where you make your free long distance telephone calls." The demand for the cards entitling the visitors to make these calls became so great that it created one of the first operating problems at the exhibit.

One of the procedures tried for distributing the cards was a system of drawings by lot. Persons desirous of making calls were given numbered tickets and drawings were held every hour. Although this method seemed to be accepted in great good humor, by persons not fortunate enough to receive the opportunity of making a call as well as those who were, it was felt to be somewhat unfair to individuals who were really anxious to participate in the long distance demonstration and willing to wait their turn to do so. It was decided, therefore, to discontinue the drawings and to have the applicants wait in line for the tickets, a procedure with which they were all familiar and ready to accept as being entirely fair. In order to make the wait for the tickets as comfortable as possible, chairs were provided in the Hall of the Electrical Echo, opening on Communications Court. Tickets were given out in the order of seating, one ticket approximately every four minutes. At few times during the Fair were there less than 30 persons waiting to apply for the souvenir calls; and on days when the attendance was especially large, as many as 50 or 60 individuals would be found waiting outside of the Echo Tower before the doors had opened in the morning. To many people the wait in the Tower was a welcome rest from the arduous business of "seeing the Fair."

As soon as a visitor had received a ticket, he was directed to the long distance demonstration on the second floor of the exhibit, where the calls were actually made. Here, he was escorted to one of the two booths at either end of the demonstration area, where he placed his call in the usual way. Outside, on a very large map of the United States, the route of the call was displayed by means of a band of light. Immediately below the map a crowd was always to be found listening in on the conversations. Originally 18 receivers were provided for this purpose, but so many people were anxious to hear the conversations that 40 additional earphones were installed; there were few times during the Fair that most of them were not in use. Apparently, the presence of the listeners did not greatly disturb the person doing the calling. As soon as the telephone had been answered at the distant point, the operator announced that the call was from the telephone exhibit at the World's Fair and that other people would be listening. Frequently, the person making the call would reinforce this statement by saying good-naturedly, "About 50 people are listening outside here, so don't bring any of the family skeletons out of the closet."

Probably at no other place on the Fair Grounds was there an exhibit more crammed with the drama, the pathos, and the humor of everyday life than at this demonstration of long distance telephone service. Members of families who had not seen or heard each other for years were reunited in the brief space of a minute. Very frequently in the conversations, emergency requests were made for money, and such comments and questions as "Why don't you write?," "We'll be home on Tuesday," "We saw so-and-so and he asked to be remembered to you." "Father and Mother are well," and even "The baby has a new tooth," ran through the conversations. One young man calling a friend in Dallas, Texas, learned over the telephone that she had been killed in an automobile accident. The reactions of the listeners to all of this were instantaneous and unaffected. A hushed silence would pervade the air of the exhibit at one moment—and at the next, amused smiles and bursts of laughter. So natural and human were the conversations that many a telephone Romeo received a good-natured kidding from the crowd as he left the booth after having completed his call.

Some 25,000 persons actually participated in the demonstration by making calls. For many of these it was their first experience with the long distance telephone. Probably double that number took part in the conversations at the points called.

FIGURE 5. IN THE HALL OF THE ELECTRICAL ECHO, WAITING THEIR TURN TO CALL LONG DISTANCE.

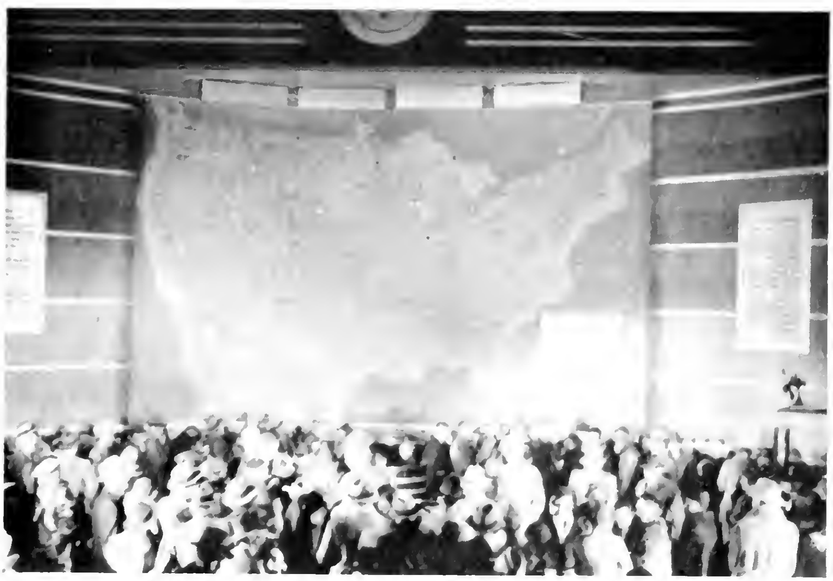


FIGURE 6. A CROWD AT THE LONG DISTANCE DEMONSTRATION.

Figure 7. Finding Out How the Dial Telephone Works.

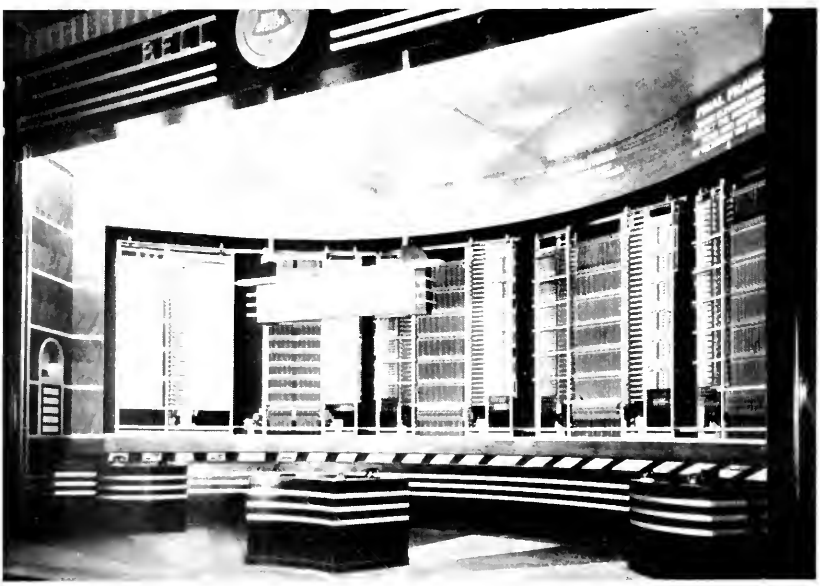


Figure 8. A General View of the Equipment in the Dial Telephone Exhibit.

Almost a million persons listened in at the exhibit. These individuals must have been impressed, unconsciously at least, by the part which the telephone plays in their everyday life. Many of the participants in the demonstration, after having completed their call, took the trouble to search out an attendant and say, in effect, "I don't know whom to thank for the call I just made, but I want you to know that it was one of the most wonderful experiences I've had at the Fair." Numerous letters of appreciation from persons who had made souvenir calls were received throughout the summer. Foremost among the comments at the demonstration itself were those expressing surprise that long distance connections could be completed so rapidly and with so little trouble over great distances. Indeed, one rather skeptical lady appeared at the Hall of the Electrical Echo early one morning and said that she had heard that now it was actually possible to talk as far as Los Angeles over the telephone. Even when assured by the attendant that this was an everyday occurrence, she shook her head rather dubiously and said that she was going to wait in line for one of the tickets just to find out if it were really so.

A third very popular spot in the telephone exhibit was the demonstration of the dial telephone. Here the equipment was arranged so that the visitors could actually see the various operations involved in completing a dial call. The five principal frames appearing in a dial central office formed the background of the exhibit, and by means of red lights on each of the frames (except the first or "sender" frame) and lighted signs at each end of the space, the visitor could trace the progress of calls which started from a telephone at the left and were automatically sent through the equipment at 30 second intervals, terminating at another telephone located at the right of the exhibit space. The greater proportion of the individuals who stopped to examine this display—many of them with the exclamation, "Oh, look, here's the dial telephone. I want to see that!"—had the equipment explained to them by a demonstrator. For this purpose, small booths were provided in the center and at either end of the area. Two telephones were placed at each of these positions and during the course of the explanation a call was actually made from one of the telephones to the other and traced through the various frames by means of small colored lights on the selector rods.

It was intensely interesting to watch the reactions of the spectators as this demonstration progressed. The dialing mechanism was usually explained first to the group of people who had gathered around the attendant's desk, and attention was directed to the equipment in the background: "These five frames constitute the five main frames which you would see in a dial central office. All of them are necessary for completing a single call from one dial telephone to another." During this announcement a number of persons who had stopped more or less casually in the aisle space to look at the equipment would begin to move into the area in order to hear the demonstration. The "sender" frame was explained as an "electrical brain" which stored up the dial impulses and sent them through the equipment at the proper time. Next, the demonstrator would pick up the telephone in the booth and, calling attention to the second or "line finder" frame, would take the receiver from the hook. The light on the rod associated with the line would light and the rod itself would rise and make connection with the calling telephone. At this point the interest of the observers would shift from the attendant to the equipment, and as the central office prefix and then the first two and last two digits of the number were dialed by the demonstrator, heads would turn and eyes would shift from one frame to the next as the call progressed to completion.

When the last digit had been dialed and the appropriate rod in the final frame had risen, the demonstrator would explain that the line of the called subscriber had been reached and that in a moment the telephone on the opposite side of the desk would ring. When this was announced, there appeared to be a general air of expectancy, which was dispelled with smiles and significant nods when the familiar sound of the telephone bell was heard. After talking with someone near the demonstrating booth, using the telephone connection established through the demonstration frames, the telephones were hung up. As the crowd watched the rods resume their idle position, the demonstrator explained that the equipment on display represented only about one-sixtieth of that found in a central office designed to serve 10,000 telephones.

One of the outstanding features of the dial display was the stimulus it seemed to provide for comments and questions on the part of the visiting public. Almost continuously throughout the day—excepting, of course, while demonstrations were in progress—visitors could be found at the attendant's desk, and the discussions covered almost every conceivable phase of dial telephone service. Typical of the comments were those indicating amazement at the extent and complexity of the equipment—illustrated best perhaps by the remark made by a visitor after a demonstration: "And to think that all this happens when I take the receiver off and dial a number!"

One of the most entertaining of the telephone exhibits, and one which seemed to have a broad popular appeal, was the demonstration of "Scrambled Speech." Some of the changes made in this exhibit in the early stages of the Exposition constitute, perhaps, the most striking examples of the effectiveness of the personalized demonstration and of the importance of the element of "showmanship" in attracting and maintaining the interest of large groups of individuals. The demonstration was carried on in a glass enclosed room just off the southern entrance to the second floor of the exhibit area. On the opening day of the Fair, all the exhibits were being closely watched, and it soon became evident that this particular spot was not getting its proper "play." Early in the afternoon a sign was painted on the entrance: INVERTED SPEECH—A Con-

TINUOUS DEMONSTRATION. The result of this was a distinct increase in the number of persons entering the exhibit. Shortly thereafter the word "inverted" was changed to the much more intriguing term "scrambled" and again the attendance showed an increase.

The demonstration itself, at the beginning of the Fair, was recorded on a phonograph record and the normal speech sounds were reproduced through a loud speaker located at the right of the exhibit area. Immediately in front of this speaker was a microphone mounted on an arm, and at a certain place in the record this arm would swing over toward the speaker, the sounds would be picked up by the microphone, sent through a speech inverter, and the "scrambled" sounds would issue from another loud speaker located at the left side of the room. This method of demonstrating proved rather popular with the visitors, but it was not until the equipment was rearranged so that personalized demonstrations could be undertaken by the attendants that "Scrambled Speech" became a highly attractive feature of the telephone exhibit.

No set procedure was, or as a matter of fact could have been, followed by the attendants in these demonstrations. Usually the general principle of speech inversion was explained as "turning the musical sounds of which the voice is composed upside down." This principle was illustrated by whistling high notes into the inverter, which came out as low notes, and low notes which came out as high. The part of the demonstration most enjoyed by the visitors, however, was that during which words were actually scrambled. The attended might ask someone standing near to say "el, el, el" into the microphone. Amused laughter greeted the "oi, oi, oi," which came from the inverter. During most of the demonstrations a request was made by the attendants for the names of home towns of the spectators. The crowd entered whole-heartedly into the spirit of the demonstration and the number of people from such places as Tuscaloosa, Philadelphia, Kalamazoo, Walla

FIGURE 9. A VISITOR SPEAKS INTO THE "SPEECH SCRAMBLER."

FIGURE 10. INSIDE THE MULTI-CHANNEL DEMONSTRATION.

FIGURE 11. LISTENING TO AN EXPLANATION OF THE CALL ANNOUNCER.

FIGURE 12. THE DEMONSTRATION OF BELL SYSTEM TELETYPEWRITER SERVICE.

Walla and Tallahassee was truly amazing. Although the attendant would not guarantee 100 per cent performance, he was usually able to catch the scrambled sounds coming from the inverter and then by repeating them into the inverting equipment, restore them to the normal form. Very frequently, after the demonstration the attendant was asked for the scrambled spelling of home town names which the visitor wanted as a souvenir of his visit to the Bell exhibit.

During the course of the demonstration, the practical use of inverted speech in providing privacy to conversations on the radio channels utilized for trans-oceanic telephone calls was explained; and the path of a call to a distant point, perhaps in Europe or South America, was traced on a large map immediately in front of the spectators. A number of people usually stayed after the demonstration to ask the attendant questions regarding the nature of the inverting equipment and other possible uses which might be made of scrambled speech, many persons suggesting, some facetiously and some seriously, that it might be a very good thing for party line service. Numerous requests were made for the telephone rates to different foreign cities. One of the most frequent reactions, however, as evidenced by the comments and questions of the spectators, was that which indicated that a great many people had not previously appreciated the fact that steps had been taken to obtain privacy of conversation on trans-oceanic telephone calls.

Around the corners from the dial and long distance areas were located small semi-circular niches, four in all, which contained positions at different types of telephone switchboards. The background of the niches was a dead black. Seated at the position was an operator. The only lighting came from an overhead spotlight which was directed on the operator and covered a small portion of the board. The result was one of the most artistic and arresting effects achieved in the entire exhibit and drew many thousands to listen to the demonstrations. Even when a demonstration had been concluded, instead of moving on to another exhibit the crowd often would remain, and it was frequently necessary for the operator to suggest tactfully, "Just around the corner you will find the dial equipment. I'm sure you would be interested in seeing that." Thousands of people who visited the telephone exhibit took this picture of a telephone operator away with them and with it, perhaps, a new appreciation of the real spirit that lies behind the telephone service.

Demonstrations were conducted at each of the positions and literally thousands of questions were asked on almost every phase of switchboard operation. At the manual switchboard people wanted to know how some specific number was located, how the calls were registered and how they were timed, how the operator knew when the line was busy and how the busy signal was given, whether she could listen in on the conversations, how party-line calls and calls to other central offices were handled, and so on. In the great majority of cases, these questions were prefaced by the recital of some kind of difficulty or some personal experience with the telephone service which the individual apparently had never quite been able to understand.

At the dial special assistance position, which is reached when the subscriber needs assistance in placing a call from a dial telephone, and at the call announcer-call indicator board, used for completing calls from dial to manual telephones, questions were asked about the operation of dial equipment, many of which indicated that the person did not realize that operators were actually required in connection with the dial system. At the latter switchboard, people were mystified by the call announcer and a great many of them actually dialed a number and heard it repeated by the mechanical voice.

At the teletypewriter exchange switchboard, the idea of "typing by wire" was apparently an amazing revelation to a large proportion of the visitors who stopped to hear the demonstration. Many of the spectators marvelled at the intricacies of the equipment and seemed particularly impressed by the fact that a girl could master its operation.

So realistic were these switchboard positions that the spectators would frequently ask, "Is that board actually operating?" and even when assured that it was only for demonstration purposes and was not handling outside calls, would question further, "Then why do those signal lights keep coming up in front of you?"

Directly inside the northern entrance there was a demonstration of the multi-channel telegraph, in which twelve messages were transmitted simultaneously over a single pair of wires which were actually shown coming out of a section of standard telephone cable. Receivers were provided on a ledge located in the center of the exhibit, by means of which the visitor could hear the different pitches of the carrier frequencies of any one of the messages, which he could select by means of a switch. On an oscilloscope at the right of the room the wave form of the messages could actually be seen. Here, too, was a tape-type teletypewriter machine which would type any one of nine teletypewriter messages which the visitor might select.

Something over 300,000 persons actually made use of the receivers in this part of the exhibit during the course of the summer. In demonstrating the equipment and explaining how twelve messages could be sent at once over a pair of wires, the attendant usually used as an analogy the tuning of a radio set which makes it possible to pick one out of a number of radio programs which might be on the air at the same time. Numerous questions were asked about the technical aspects of the demonstration, particularly by younger men and boys of high school age, who seemed to be technically inclined or who had some knowledge of telegraphy. Many people were surprised to learn that this system was actually in practical use and that a single pair of wires could carry several telephone conversations as well as code messages without interference.

Directly below the multi-channel exhibit on the first floor was additional Bell System space devoted to a display of telephone equipment for home and office use and, in addition, certain of the research developments, including the artificial larynx, a floating steel bar, "delayed speech," a photo-electric cell, and so on, which were brought from the Bell Telephone Laboratories. Here again the effectiveness of the personalized demonstration was strikingly illustrated. Demonstrations of this apparatus by an attendant brought large crowds into the area where they could see and discuss with other attendants the telephone equipment on display. There was no attempt made to do any actual selling; rather, the effort was merely made to familiarize the visitor with different kinds of telephone equipment so that he would have a better idea of what was available if a need should arise in the future. During the course of the summer, at the request of visitors, several hundred appointments were made for home demonstrations of the Western Electric Audiphone for the hard of hearing.

Just south of this area, on the first floor, was a second space containing a number of exhibits designed to acquaint the public with services rendered by the Bell System in the field of long distance communication primarily for business purposes. Hundreds of demonstrations of Bell System exchange teletypewriter service were given by teletypewriter operators during the summer, for which two machines were provided which could be connected in the regular manner through the teletypewriter exchange switchboard on the second floor. Another popular feature displayed in this exhibit area was an oscilloscope which showed the wave form of musical notes and speech sounds. Connected to the oscilloscope was an ordinary handset telephone which could be used by the demonstrator in explaining the function of the apparatus in the development of telephone transmission. Great amusement was afforded the spectators, who, by speaking into the transmitter, were able to "see" their own voices. This setting provided an excellent opportunity for the attendants to discuss with interested per-

FIGURE 13. THE LOCAL COMMERCIAL EXHIBIT AREA ON THE FIRST FLOOR.

FIGURE 14. LISTENING TO A DEMONSTRATION OF THE ARTIFICIAL LARYNX.

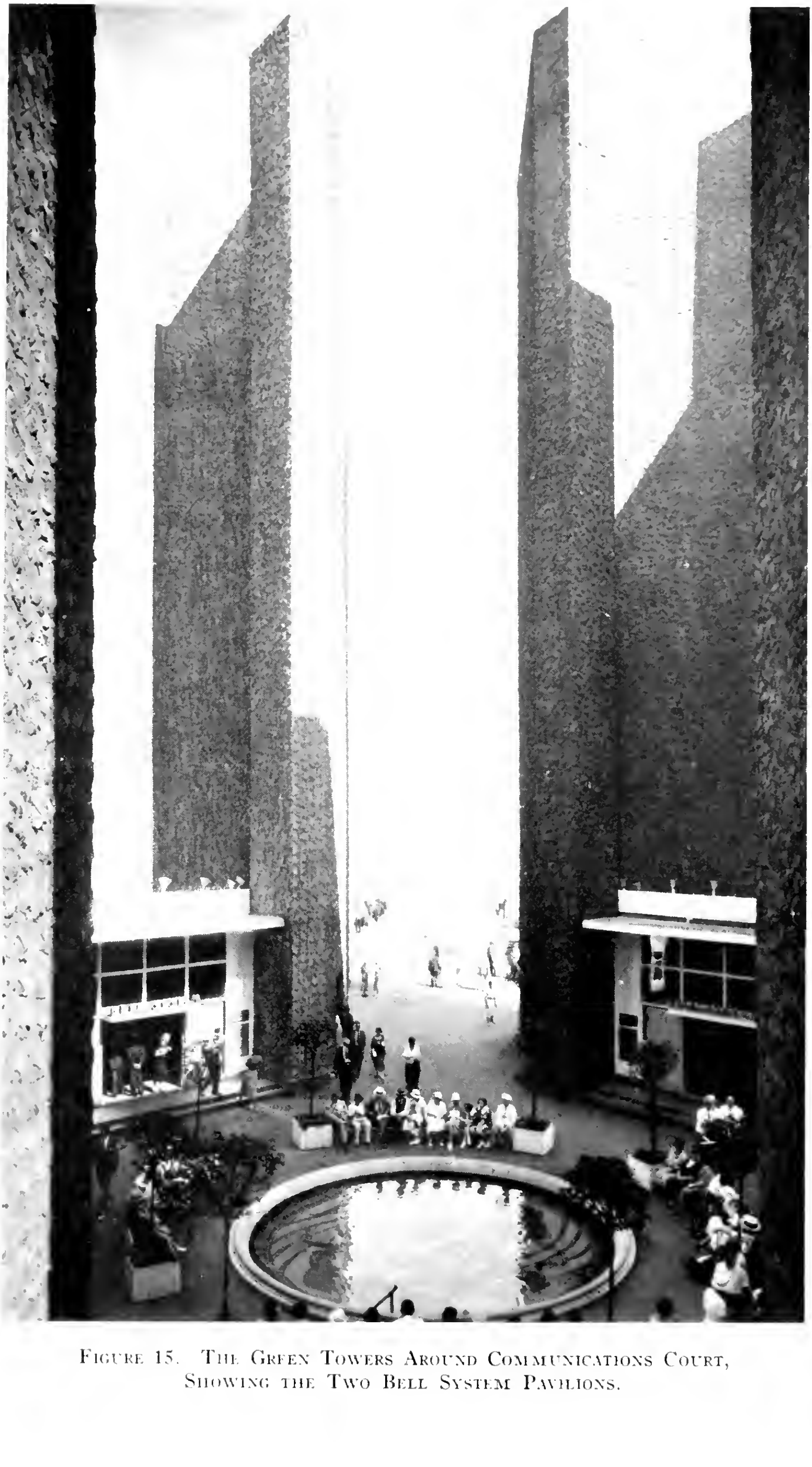


FIGURE 15. THE GREEN TOWERS AROUND COMMUNICATIONS COURT, SHOWING THE TWO BELL SYSTEM PAVILIONS.

sons the possible application of the equipment demonstrated to individual business problems.

Directly outside, and between the Hall of Communications and the lake shore, was Communications Court; and judging by the enthusiastic comments which were made by the visitors, it was apparently one of the most attractive spots on the World's Fair grounds. The Court itself was formed by four large green towers, in the center of which was a circular pool inlaid with a mosaic design emblematic of world-wide communications. Two of the towers contained the institutional exhibits of the Western Union Telegraph Company and International Telephone and Telegraph Corporation. In another of the towers was located the historical exhibit of the Bell System, a number of institutional dioramas, and an electrical echo by means of which the visitors could hear a perfect delayed reproduction of their own voice. This echo afforded great amusement to the visiting public and especially to those people waiting in the pavilion to receive their tickets for the souvenir long distance call. The other tower was used as the executive headquarters and contained registers for Telephone Pioneers and guests of the exhibit. These registers contain many distinguished names and will become a permanent and important part of the record of the telephone exhibit at A Century of Progress Exposition.

The operation of the telephone exhibit was under the direction of Dr. Sergius P. Grace, Assistant Vice President of the Bell Telephone Laboratories, who was the executive representative of the American Telephone and Telegraph Company at the Exposition. Assisting Dr. Grace was Mr. H. S. Hanna as Director of Exhibits, and as Engineer of Exhibits, Mr. R. L. Shepherd, who remained in charge while the exhibit was being dismantled at the close of the Fair.

To care for an average of something over 37,000 persons a day and to maintain the complicated telephone plant at the exhibit was a tremendous undertaking, which required a systematic plan of operation and an adequate force of attendants and technical men. Throughout the day about 35 persons were to be found on duty at the telephone exhibit. Since the operating period ran from ten in the morning until ten in the evening every day during the Exposition, three shifts were necessary to keep the exhibit in full operation at all times. The demonstrating staff, selected largely on the basis of personality, ability to talk with people, and knowledge of the equipment and services which were to be demonstrated, was chosen largely from the regular employees of the Illinois Bell Telephone Company and some were also selected from the personnel of the Chicago offices of the Long Lines Department. To maintain the telephone plant at the exhibit, much of which consisted of delicate laboratory apparatus and rather specialized telephone equipment, a skilled technical force was recruited from the Illinois Bell Telephone Company and also from the Western Electric Company in Chicago. A course for the staff, covering a period of about a month, was conducted prior to the opening of the Fair. In this course instruction was given in fundamental Bell System policy and on matters relating to telephone operation which were considered as those most likely to be raised by the visitors to the exhibit.

The many favorable comments of the visitors are testimony to the intelligent and considerate treatment they received from the exhibit personnel. It was recognition of this splendid public reaction which Mr. Walter S. Gifford, President of the American Telephone and Telegraph Company, expressed in the following telegram sent to Dr. S. P. Grace at the close of the Fair:

"Will you please express to those who had to do with presenting the Bell System exhibit so favorably to the public my deep appreciation of a job well done. Measured by the innumerable compliments received, you and your associates from the various branches of the System have reasons to feel proud of your splendid accomplishment. The exhibit thrilled me and

I am sure it entertained and impressed the millions of people who made it a part of their tours of the Century of Progress."

A broad vision and years of careful planning lay behind the creation of the exhibit. Effective organization and keen understanding of human nature made it possible to give millions of individuals a new vision of the achievements which have made nation-wide telephone service a reality. There was something at the telephone exhibit for persons of all interests, but underneath was a common message which five million visitors took away with them. They learned about telephone progress, yes; but they learned in addition that the real story of telephone service as exemplified by the Bell System exhibit is a story of progress in human relations. They sensed that the telephone business deals in the most priceless of all commodities: human contacts; and that the essence of telephone service is not machines but men.

Rather late one evening along toward the end of the Fair, an old lady, walking with a cane, came into the office of the exhibit.

"May I talk with the man in charge of your exhibit?" she asked of one of the attendants. "I promise not to take much of his time."

She was taken to the desk in the center of the office. Here is her story:

"I hope I'm not causing you any trouble," she started rather nervously, "but I did want to make a very special request. I know that you allow only one of the free long distance calls to an individual, but I was hoping in my case that you might make an exception. I know it's asking a lot, but it would mean so much to me if it could be done.

"I have a sister in Los Angeles who is a cripple. We have not seen each other for twenty years. Our circumstances are such that we shall probably never see each other again.

"When I first learned that the Telephone Company was letting its visitors make free long distance calls, I wrote to my sister and told her that I would call her on October 18. She was to be brought downstairs in her wheel chair that day and I wanted to be sure that she would be near the telephone. How long I might have to wait for my card and she for the telephone to ring made no difference to either of us.

"I made the call that day," she said, reaching into a small handbag for the souvenir card which she had been saving and which she placed on the desk. "My niece answered the telephone. I had made a dreadful mistake. In my letter I had said the 25th instead of the 18th. My sister was upstairs, and before she could be brought down I knew that my three minutes would be up. There was nothing we could do; I was dreadfully disappointed."

During this part of the conversation, the card which contained the name and telephone number of the sister had been quietly taken from the desk. In the background a voice could be heard: "Long distance, please. I want Los Angeles, California . . . "

"I know it would be taking someone else's time who might be making a call but it would mean so much . . . "

A quiet voice interrupted, "I've been getting your sister in Los Angeles. She will be downstairs in just a minute—here she is now."

The hand that took the telephone was trembling.

C. T. Smith

Editor's Note: Mr. Smith is of the staff of the Chief Statistician of the American Telephone and Telegraph Company and was assigned the work of recording and analysing data relative to results of the Bell System Exhibit at the Century of Progress Exposition.

Systems of Long Telephone Lines

AS WE review the panorama of progress in the provision of constantly improving means of communication, we consistently find that greater speed is one of the outstanding advantages of each new method.

The telephone makes available such an advantage, in that it is possible by its use for persons who are separated by greater or less distances to be quickly interconnected by wire or radio and to carry on conversations with much the same facility as though they were face to face. The speed with which the connection can be established is undoubtedly an important reason for the rapid growth and present extensive use of long distance telephone service.

But although speed in the conduct of affairs is ever present as an objective, it must be obtained at a reasonable cost and with consistent reliability, if new and quicker methods are to be of value and keep a place in the scheme of things for other than a relatively brief period. Therefore, in the planning of a system of telephone lines, the question of reliability of service plays an important part, not only in the design and assembly of the materials used, but in the broad selection of routes and allocation of circuits to such routes. In the following discussion a few examples will be given of things that have been done with respect to the latter two items in building up the network of longer toll lines operated by the Bell System so that the service is not only generally fast but reliable.

From Single Lines to Alternate Routes

From the beginnings of long distance telephony, it has been the popular thought that service between any two cities involves merely a single line. This is natural enough, for the development and expansion of long distance service in this country was effected by means of such lines stretching southward and westward from the northeastern industrial centers. We recall that the first New York-Boston line was completed in 1884. The New York-Philadelphia line was completed in 1885. The New York-Chicago line was opened in 1892, just ahead of the Columbian Exposition. The first transcontinental line, giving direct connections between the east and west coasts, was placed in service in 1915, the year of the Panama-Pacific Exposition.

The completion of each of these various lines was hailed at the time as "a triumph of modern telephone engineering." They were well designed and soundly constructed and gave excellent service. However, when a sleet storm, tornado, fire, flood or other cause temporarily interrupted the service on any of these initial lines, the service remained interrupted until repairs could be made. As lines increased in length, the exposure to causes of interruption became greater. The very causes of these interruptions often made it of increased importance to the public that telephone communication be available. To help maintain communication at all times, it has been found desirable, therefore, to have, wherever practicable, more than one line between cities and sections of the country and to have the lines so located that storms or accidents which affect the one are unlikely to interrupt service on the other at the same time. We call these additional lines alternate routes. They are usually made up of lines which are direct connections between points other than those located on the primary route. For example, the normal routing of the seven telephone circuits now in the Pittsburgh-St. Louis group is in direct cables by way of Columbus and Indianapolis. An alternate cable route for these circuits is by way of Cleveland, Toledo and Chicago. A brief study of the accompanying maps will reveal that alternate routes have now been made available between most of the important points in the Bell System.

Lines are planned primarily for the handling of business between the points connected and acquire important signifi-

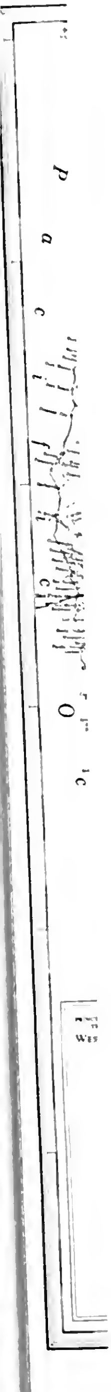


FIGURE 1. DETAILED MAP SHOWING THE LINES OF THE BELL SYSTEM.

cance as alternate routes incidentally or through the working out of plans made in advance with this feature in mind. The southern transcontinental line (by way of St. Louis, Dallas, El Paso and Los Angeles), for instance, was completed both because of the need for additional circuits to the southwest and because of the great responsibility carried by the central transcontinental line (by way of Chicago, Omaha, Denver, Salt Lake City and San Francisco) when it was the only telephone route to the Pacific Coast. One of the reasons for installing the first Philadelphia-Washington cable (1912) was to protect service into Washington which previously had been furnished exclusively by open wire lines.

General Circuit Design

The matter of circuit design becomes of increasing importance when we consider an interconnected system of routes. A specific circuit arrangement which would operate effectively on a direct route between two points might not be satisfactory if changes are later required or if it should be necessary to use it in building up longer alternate routes. It is the history of most industries that changes are required from time to time for numerous reasons, some of which cannot be foreseen, and a design which permits of reasonable future rearrangements in the direction indicated by prevailing trends can have great influence on economy and efficiency of operation.

In toll cable plant, the trend in recent years has been to use uniform or standardized circuit arrangements for new work, as far as practicable; and for the longer cable circuits, say over 200 miles, to use the so-called 4-wire or 2-path lightly loaded circuit which, with existing equipment arrangements, is capable of providing good service through cables up to about 2,000 miles. So far, cable circuits longer than this have not been generally required, but they can be made available when needed. Also, by using combinations of cable and open wire, good service can be given over much longer distances. At

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In toll cable plant, the trend in recent years has been to use uniform or standardized circuit arrangements for new work, as far as practicable; and for the longer cable circuits, say over 200 miles, to use the so-called 4-wire or 2-path lightly loaded circuit which, with existing equipment arrangements, is capable of providing good service through cables up to about 2,000 miles. So far, cable circuits longer than this have not been generally required, but they can be made available when needed. Also, by using combinations of cable and open wire, good service can be given over much longer distances. At present, the cable circuit arrangements referred to above comprise about seventy per cent of the cable plant of the Long Lines Department. This 4-wire type of cable circuit is only slightly more expensive in first cost than other types of toll cable circuits that might be used for distances somewhat over 200 miles, but the possibilities of economically using combinations of it over various routes, and without too rigid adherence to original planning, in the event of changes in conditions, makes for greater flexibility and better service. It is thus an important factor in making it practicable to use alternate cable routes freely and efficiently, not only in emergencies, but in regular service as may be found desirable.

Modern practice in open wire circuit design has also made practicable the extensive use of alternate routes for both emergency purposes and regular operation. This is due to the fact that we now have circuit arrangements available which might be considered as broadly universal for application in those sections of the country where cable is not justified. An outstanding feature of this practice includes the general use of telephone repeaters, which made practicable and desirable the abandonment of loading on long open wires; and this in turn made possible the present extensive use of carrier telephone systems. This chain of developments brought about greatly improved transmission characteristics and practically removed distance as a limiting factor in open wire telephone circuit layout work.

Thus, in so far as the matter of general circuit design is concerned, we are in the fortunate position of being able to lay out a system of open wire and cable lines interconnecting points throughout the country for direct service but, over and above that, to build up alternate routes economically for use either in emergencies or for regular service with far less regard to distance limitations than was the case a couple of decades ago.

Alternate Routes Used in Regular Layouts

The shortest distance between two points is a straight line connecting those points and, other things being equal, telephone circuits are naturally constructed on such lines. However, the factors of reliability and overall economy very frequently dictate the use of less direct routes. For example, the major part of a direct line connecting New York and Cleveland would pass across northern Pennsylvania through mountainous country where the construction and maintenance of lines would be difficult and expensive. A cable route which is used through Reading, Harrisburg and Pittsburgh, though about 50 miles longer, is generally through less rugged country, directly serves larger intermediate cities, and is the more economical for conditions which have existed to date.

Sections of many lines built for direct service between certain cities may be combined to provide circuits in a roundabout way between other cities where the requirements are not sufficient at the time to justify direct lines. In such cases, the first lines serve as an alternate route to postpone construction until such time as business between the latter cities has grown to a point which will justify economically the construction of a direct line. After the construction of the direct line, the first lines then serve as an alternate route for purposes of protection. To cite an example, service between Chicago and Seattle was provided over the central transcontinental line by way of San Francisco and north to Seattle until the volume of business justified the construction of the northern transcontinental line by way of Minneapolis, Fargo, Helena, and Spokane. Further, a fourth transcontinental line by way of Kansas City, Albuquerque, and Los Angeles was built to handle traffic which was beginning to overload the southern and central transcontinental lines. This new line provides a route between Chicago and Los Angeles which is about 400 miles shorter than that provided by either of the other lines but much of it passes through a territory where there are few intermediate points to be served, hence its construction and use was justified by the direct business.

The growth of direct lines has been such that there are today practically no large cities in this country which, for telephone and telegraph service, cannot be reached from more than one direction over the Bell System network of open wire lines and cables. This extensive network makes it possible, in many cases, to set up the normal circuits into a given city from more than one direction in order to insure more reliable service. It has, therefore, become the practice, where a second route is available and its length is not such as to make its regular use excessively costly, to divide the circuits connecting two cities between the direct route and the second route in order to insure practically continuous service.

The circuits assigned to the various transcontinental lines are, in so far as practicable, divided between them or routed in such a way as to obtain a high degree of protection to the service. A few examples shown in the following table may be of interest. As future circuits are added, it is expected that there will be a still greater distribution.

Circuits	Total Circuits	Number of Circuits Assigned to Transcontinental Routes by Way of					
		El Paso		Albuquerque		Salt Lake City	
		No.	Length	No.	Length	No.	Length
Chicago–San Francisco	10	2	2920	1	2730	7	2390
New York–San Francisco	6		—		—	6	3210
Chicago–Los Angeles	11	8	2690	2	2330	1	2820
New York–Los Angeles	8	7	3150	1	3210		—
Kansas City–Los Angeles	2	1	1850	1	1770		—
Denver–Los Angeles	7	1	1520	5	1210	1	1210

The majority of these telephone circuits are used for long distance telephone calls. Some are used for transmission of music and speech for radio broadcast purposes. Still others

FIGURE 2. THE SOUTHERN TRANSCONTINENTAL ROUTE NEAR PHOENIX, ARIZONA.

FIGURE 3. ANOTHER TRANSCONTINENTAL ROUTE ABOUT 150 MILES NORTH OF THE ONE SHOWN IN FIGURE 2.

The three routes shown on this and the next page traverse territory of quite different characteristics. Certain circuit groups are divided so that some circuits are assigned to each line. The existence of these alternate routes results in more continuous service.

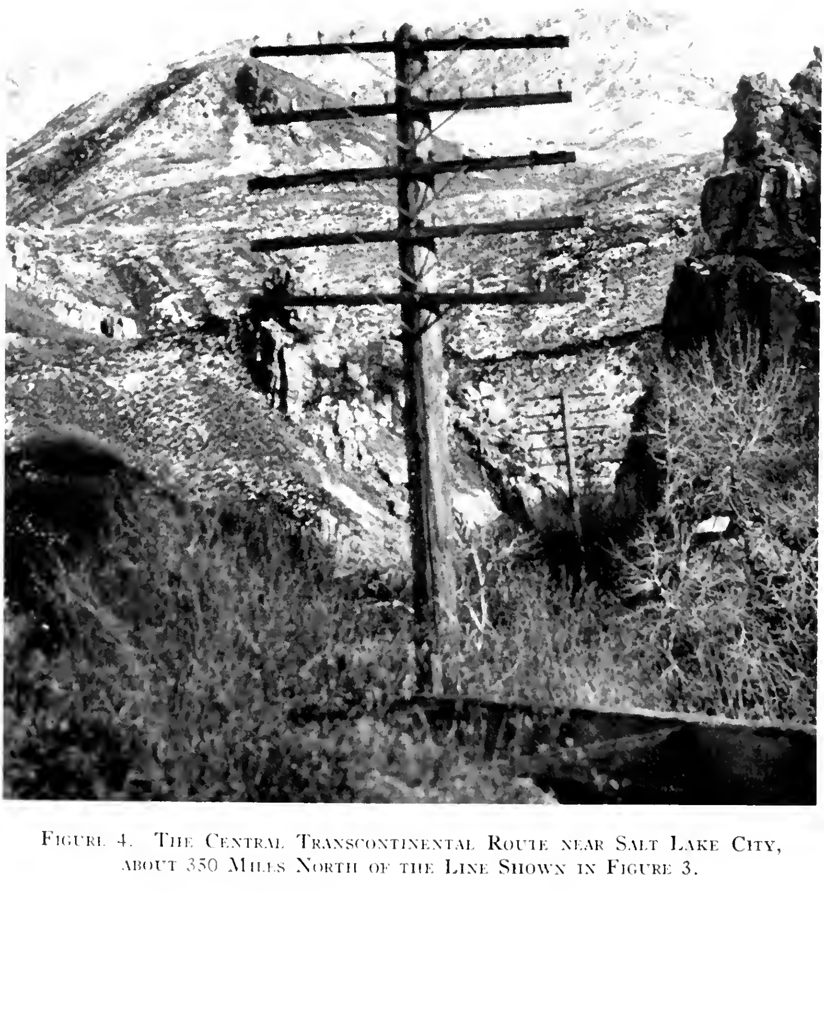

FIGURE 4. THE CENTRAL TRANSCONTINENTAL ROUTE NEAR SALT LAKE CITY, ABOUT 350 MILES NORTH OF THE LINE SHOWN IN FIGURE 3.

Figure 5. Two Cables on One of the Harrisburg-Pittsburgh Routes. This Route is through Bedford.

The two cable lines shown on this and the next page are part of an extensive system of cable routes which interconnect most of the large cities in the central and eastern parts of the country. More than 1,000 long distance telephone circuits can be provided by these four cables.

Figure 6. Two Cables on Another Route between Harrisburg and Pittsburgh, through Altoona.
This route and the one shown in Figure 5 are separated by about 40 miles at this point.

are used for voice frequency carrier telegraph systems, each of which provides 12 telegraph circuits.

With the growth of the cable network which covers the central and eastern part of the United States, the number of possible alternate routes to which circuits connecting two points can be assigned has, in general, been greatly increased. For instance, between New York and Chicago there are two completely different cable routes and two other partially different routes by means of which service between these points could be taken care of. The first of these completely different routes is via Albany, Buffalo, Cleveland and Toledo, and the second via Harrisburg, Pittsburgh and Terre Haute. Cables interconnecting points on these two routes make available still other possible alternate routes.

There are 63 telephone circuits between New York and Chicago which are used largely for long distance calls between these cities. In addition, there are ten telephone circuits in service between these points which have been specially designed and constructed for transmitting program material for broadcast purposes and fifteen circuits which are used for voice frequency telegraph systems and provide 180 telegraph circuits. Five circuits are set up for use in emergencies. There are, of course, assigned to these same routes many other circuits connecting intermediate cities or cities beyond the terminals of the section.

These 93 direct circuits which connect New York with Chicago are distributed on the various routes in the following manner: Seven by way of Buffalo, Cleveland and Toledo; 64 by way of Pittsburgh, Cleveland and Toledo, and 22 by way of Pittsburgh, Dayton and Terre Haute. Although 86 of these circuits are at present assigned to the same general route between New York and Pittsburgh, they are distributed among the four cables which are available in this section and these cables are so located that in effect they provide more than one route. Between New York and Reading, one of the cables is underground and three are on a pole line, while two aerial cable routes are used from Reading to Pittsburgh. There are also from two to four cables in the Cleveland-Chicago section located on two separate routes, excepting between Toledo and South Bend, and the circuits are distributed in the several cables.

There are two completely different cable routes possible between New York and Boston and partially different routes in some of the sections. One of these routes is by way of Hartford and Providence and is 230 miles long. A second partially different route is by way of Hartford, Springfield and Worcester and is almost exactly the same length as the first. The cables are entirely underground excepting for the section between Springfield and Worcester on the latter route. A third route is by way of Albany, Springfield and Worcester and, although about 100 miles longer than the other two, serves as an alternate route to protect service normally routed over them.

Between New York and Washington, the normal route is by way of Philadelphia and Baltimore in underground cable. There is, however, an alternate cable route by way of Harrisburg and Baltimore.

As pointed out earlier in this article, alternate routes are frequently used to defer the construction of more direct routes until the volume of business is sufficient to make the construction of a direct route economical. This method of deferring construction projects is used to a large extent and it is one of the factors permitting the furnishing of good service with the least cost. Examples of this practice are mentioned below.

A section of the central transcontinental line west of Omaha is completely filled with circuits. To defer the construction of an additional line or some other form of relief, some circuits which would normally be assigned to that line have been assigned to the southern transcontinental lines. Although the circuits are somewhat longer than those on the central route, the existence on these other routes of pole line capacity and circuits which are temporarily spare makes their use in this manner an economical procedure.

The construction of a toll cable between Terre Haute and St. Louis was deferred for about three years by using facilities that had been provided for future growth over cables between Terre Haute, Danville, Springfield and St. Louis.

The direct route for business from Chicago to Florida points is by way of Cincinnati or Louisville through Atlanta to Florida. However, the addition of facilities between Cincinnati, Louisville and Atlanta has been deferred by routing part of the Chicago circuits to Florida points over toll cable conductors to Baltimore and through Washington to the south, using facilities that are temporarily spare on this alternate route.

Alternate Routes Used in Emergencies

When a direct route between two points fails because of storm damage or other causes, the existence of an alternate route makes possible the quick setting up of emergency circuits so that service may be restored without waiting for the repairs to be completed on the direct route. This function of an alternate route is of great importance in maintaining uninterrupted long distance telephone service. For instance, should a portion of the central transcontinental line be destroyed by a storm, it might be hours or even days before service between New York and San Francisco could be restored, if this were the only route available. Actually, however, the service is usually restored in a few minutes by using circuits over one or both of the other transcontinental lines to Los Angeles and the Los Angeles-San Francisco cable between the latter two points. Such a circumstance has occurred a number of times. On November 20, 1930, an unusually widespread, wintry storm broke down sections of three of the transcontinental lines, leaving the southern line, by way of El Paso, as the only connection to the Pacific Coast. So great was the loss of circuits that it was, of course, impossible to reëstablish all of them over the route through El Paso, but every possible facility on that line was used. Enough circuits were established, however, so that telephone and telegraph service was continued to points on the Pacific coast.

An unusually roundabout emergency circuit was set up for a period of five days in December, 1931, when, because of the destruction by storms of a short section of line in an area difficult of access between San Francisco and Seattle, a circuit was set up by way of Chicago, using the central and northern transcontinental lines. The normal length of a San Francisco-Seattle circuit is about 900 miles, but the emergency circuit was about 4,800 miles long.

The normal route for the 28 circuits between Chicago and Minneapolis is over cable and open wire lines through Milwaukee and Madison, Wis. The route which protects this service is that via cable to Davenport and north through Waterloo over the Davenport-Minneapolis line. There have been numerous instances in which this route has provided the only service between Chicago and Minneapolis, because of failure of the more direct routes due to storm damage.

Another instance of the use of alternate routes for the emergency reëstablishment of service occurred at the time of the opening of service to Mexico City, September 29, 1927, by President Coolidge and President Calles. For the purposes of the opening, circuits had been set up between Washington and Mexico City by way of St. Louis and Dallas. A few hours before the official opening time, a failure of the wires occurred near St. Louis, due to a tornado. An emergency circuit was immediately set up by way of Atlanta, New Orleans and Dallas, and another from Chicago via Omaha and Kansas City. These routes were selected as reports indicated that they were well outside the storm area. The program was carried out without any delay, using the route via Omaha, and most of the speakers, of course, never knew the difference.

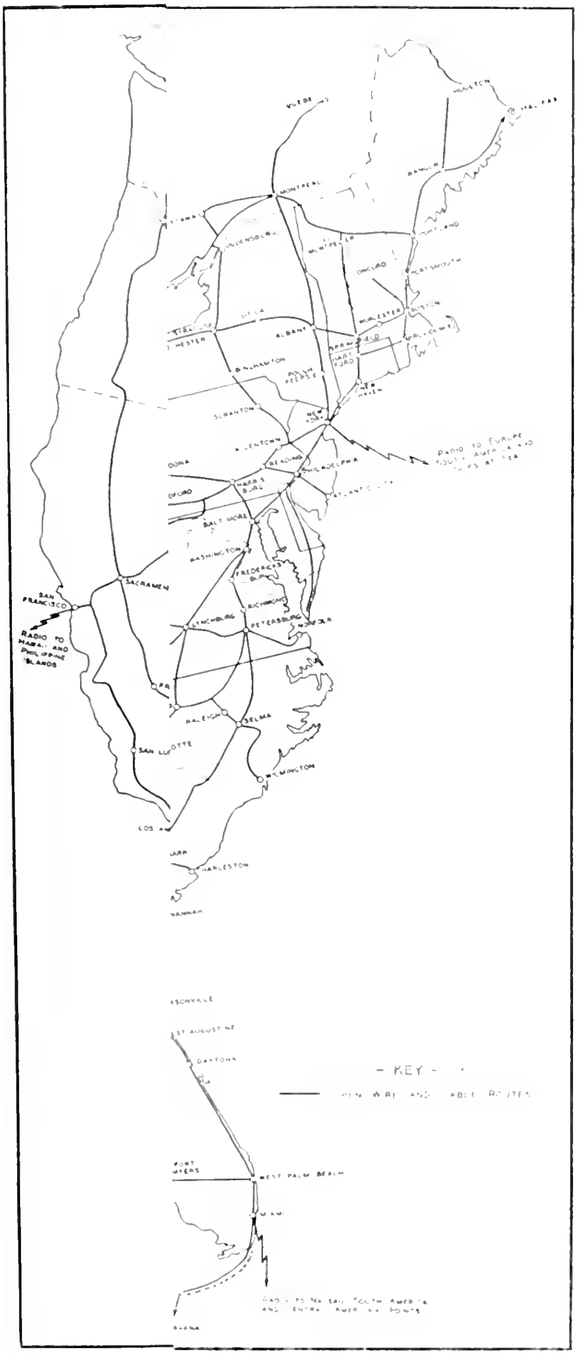
MONTREAL
ALBANY
BINGHAMTON
SCRANTON
NEW YORK
ALLENTOWN
READING
PHILADELPHIA
RADIO TO EUROPE
HARRISBURG
WASHINGTON
RICHMOND
LYNCHBURG
PETERSBURG
SACRAMENTO
SAN FRANCISCO
RADIO TO HAWAII AND PHILIPPINE ISLANDS
RALEIGH
SELMA
DAYTONA
WEST PALM BEACH
- KEY -

FIGURE 7. MAP SHOWING SOME OF THE ROUTES USED FOR THE LONGER BELL SYSTEM TELEPHONE AND TELEGRAPH CIRCUITS.

Directing the Circuit Layout

To accomplish effectively all of these normal routings and the establishment of circuits in the event of emergencies over alternate routes, a plan of coördinated organization has been built up. The functions of the various parts of this organization are divided somewhat between the normal assignment of circuits and the emergency assignment of circuits.

The actual determination of the route and wires to which circuits are normally assigned is, in the case of the Long Lines Department, in the hands of a centralized circuit layout bureau made up of representatives of the Engineering, Traffic and Plant Departments. This bureau designs the overall circuits and makes sure that the combinations of wires, telephone repeaters, carrier systems and other apparatus which are to be used will give satisfactory transmission when connected together. It also issues written instructions as to the specific routes and wires to be used and how they should be interconnected.

These arrangements are supplemented with a plan under which changes in circuit layout can be made quickly on the ground. This is necessary because of unpredictable changes in traffic volume (frequently of short duration), circuit failures, and special service requirements.

This work is performed by Traffic Control bureaus located at Traffic Division headquarters, each of which is connected with the Long Lines operated offices in its area. Interconnection between bureaus and the centralized circuit layout force is provided. These bureaus keep in constant touch with the actual current conditions at each of their offices and arrange for the necessary changes in circuit layout as the needs indicate.

When additional circuits are required as the result of some major event involving the public interest, their provision is expedited through this Traffic Control system. For example,

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When additional circuits are required as the result of some major event involving the public interest, their provision is expedited through this Traffic Control system. For example, immediately following the southern California earthquake in March, 1933, the circuit layout from Los Angeles to the east was increased quickly from 45 to 79 circuits, or seventy-five per cent. Demands for service were, of course, extremely heavy. The first banking holiday in March, which came without prior notice, made necessary an increase in circuits at Detroit from 187 to 262, or forty per cent. At Cleveland, a few days later, the circuit layout was increased by fifty-eight per cent. From then on, the layout between other cities was progressively increased by joint action of the Traffic Control bureaus and the centralized circuit layout unit in New York. The total additions during the three weeks of the emergency amounted to 1,300 circuits, and affected the layout to 180 cities. The possibility of using alternate routes freely in cases of this kind is, of course, an important factor in maintaining good service.

For each long distance circuit set up, an office of the Plant Department, usually one of the terminal offices of the circuit, is made responsible for the over-all conditions of that circuit from the standpoint of transmission efficiency. This responsible office is called the Circuit Control office, and it directs in a general way the testing and trouble clearing on the circuit. It is through this office that the Traffic Control bureau directs any temporary changes which it wants made in the layout of the circuit. This office also directs, in accordance with orders from the circuit layout bureau, the original establishment of circuits on their normal routes. The intermediate offices along a circuit are responsible for the detailed maintenance of the wires and equipment which make up the circuit. They perform regular checks and tests on both, in order, so far as possible, to anticipate and prevent troubles. When troubles do occur, these offices, under the direction of the Circuit Control office, assist in locating the trouble and in restoring service by setting up emergency circuits over spare wires on the same or other routes.

Conclusions

Considering the layout of long telephone lines in this country as a whole, we have, therefore, advanced from the stage where cities and even large sections of the country were connected by only one route. We no longer refer to the New York-Chicago line, but rather to a system of lines connecting these points, designed so as to give good transmission and to be as free as possible from interruptions and with the component routes so separated that a complete interruption to one is unlikely to affect the others. In 1915, a single transcontinental line with a maximum layout of three circuits provided the telephone communication between the Pacific Coast and the eastern part of the country. There is now a system of transcontinental lines. Four of the routes extending to the Pacific Coast are widely separated and traverse the country between the Canadian and Mexican borders. Each carries many telephone and telegraph circuits and the lines are so interconnected that a high degree of security can be obtained. These and other examples referred to may illustrate the progress which has been made in developing a system of long telephone routes and the advantages which such a system affords in the day to day rendering of service to the public.

J. J. Pilliod

The Rôle of Drop Wire

THE outside plant structure known in telephone parlance as the "drop" is the insulated pair of aerial wires that connects a cable or open wire circuit with the "inside" or house wiring of a subscriber's telephone.

While drop wires in some form are as old as the telephone business itself, the drop wire's history lacks the glamor that surrounds the more spectacular elements of telephone plant and it has received little recognition in telephonic literature. Yet of the thousands of inanimate things involved in the romance of the telephone, few have had a more interesting part than drop wire. It is unique in its adaptability to a wide variety of uses, and these many uses have kept it in close contact with human affairs when events large and small were marking epochs in the lives of many telephone people. Besides its usual function of connecting aerial cable circuits to telephones, it is called upon to serve in the place of open wire and cables for the quick restoration of service after storm breaks and floods, to perform as temporary patching lines for the purpose of avoiding interruptions to service during construction and reconstruction work, and to serve temporarily as submarine cable and as line wire extending beyond the ends of cables.

Difficulties Imposed by Its Environment

Drop wire is also unique in the diversity of the hardships it undergoes, which in some instances induce human hardships as well. In the well designed aerial cable plant every element of the plant, including drops, is safeguarded as far as practicable against injury caused by existing or probable future conditions of its environment. The poles have been selected as to size and height and have been carefully located; the cable has been fastened at predetermined heights on the poles and guarded by location and certain devices from wear or other injury by tree limbs, power wires and other things; terminals have been joined to the cable at certain poles which are most suitable for drop wire connections, and the drops are run from these points to subscribers' buildings by routes that introduce the least practicable hazard to the drops. The drops, however, are installed after the cable and terminals are in place, some of them years afterward when the environment of the drops may have undergone an important change. Such a change may be due to the planting or growth of trees, changes in other wire services, or changes in the distribution of telephones. Whatever the cause, it is common to find that many drops necessarily have a very unfavorable environment, where they are subjected to great abuse from which the more massive elements of plant, such as cable, remain relatively free.

It is fair to state that, as compared with cable and most of the other elements of plant, the drop has the most vulnerable position. Unlike the telephone and other inside equipment, which are well housed and protected against the rigors of outdoor exposure, and unlike the cable which, though exposed outdoors, is systematically engineered into place and strongly supported, the drop must support itself outdoors in the gap between the cable and the building that houses the telephone, no matter whether the span be short or long, over, under, around or through trees or other obstructions. By the very nature of the service it must render, it often must endure much abuse.

The form of abuse which causes more drop wire trouble than any other is abrasion, which is best illustrated by branches of trees rubbing against the wire. This wears off the insulation and reduces the insulation resistance of the wire to ground, especially during wet weather when the leakage may make the circuit inoperative. Then it becomes an element in a human drama, a part of which may be heard but not told, for it is then the troubleman goes out into the wetness to find and clear the trouble; and if the sun comes out and dries him off, and thus relieves his physical discomfort, it may also dry off the drop, causing the trouble temporarily to disappear, which adds to his difficulty in locating it. Trouble of this kind has been combated practically since the beginning of the telephone business, particularly by the specialists concerned with development work. It apparently began even before the drop received its present name.

Origin of Its Name

It is found that the very early records refer to drops as "leading-in wires," "cut-in wires," or merely "exterior wires." However, at least by 1895 the term "drop" was being employed, for we have a record of its use by the Wire Department of the City of Boston in the following rule promulgated by it in that year:

> "To be brought below the roof of a building, the drop must commence at the top of the same building and run straight down between and not in front of windows, hoistways, etc., and as near the wall as the character of the service will admit."

This rule suggests that "drop" as applied to wire was then a well known term and that it originated in connection with house top distribution. Another one of the rules makes it clear that the term was also applied to electric light and power wires. The house top distribution referred to was the truly overhead system which is portrayed in Fig. 1. The line wires were run from building to building and block to block on fixtures such as these. Some of these fixtures were thirty-six feet high and carried two hundred or more wires.

Major Development Steps

It appears that originally there was no distinction between drop wire and line wire and that drops were merely bare line wires dropping from the line to the buildings. It was soon found, however, that wet tree limbs with which they were often

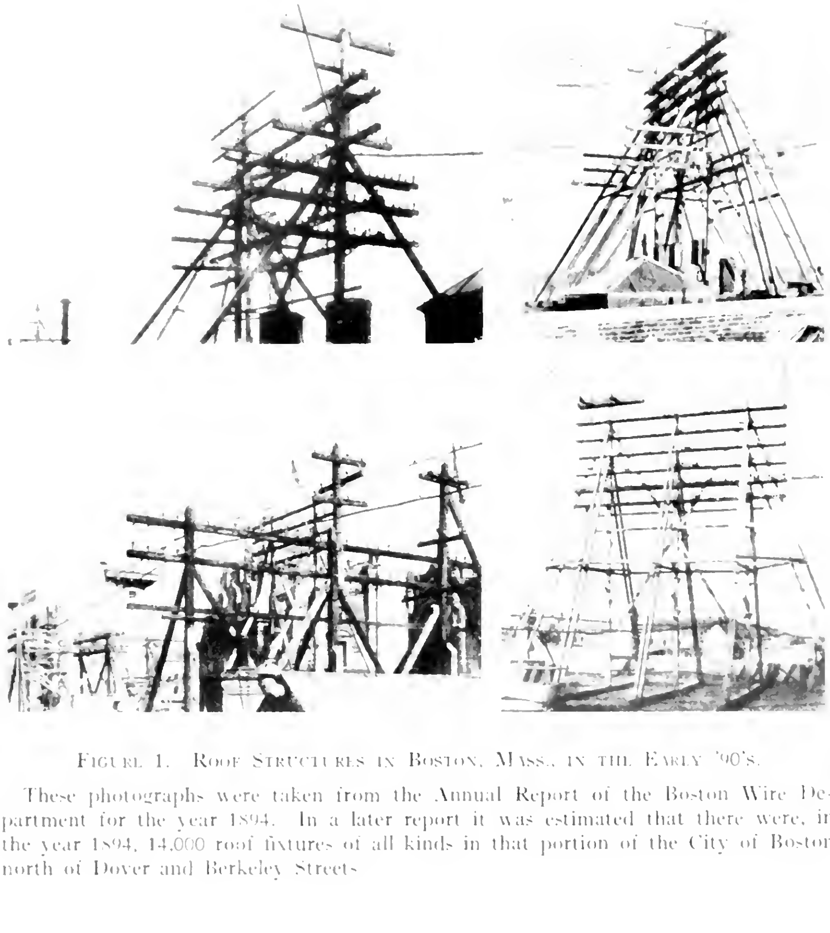

Figure 1. Roof Structures in Boston, Mass., in the Early '90's.

These photographs were taken from the Annual Report of the Boston Wire Department for the year 1894. In a later report it was estimated that there were, in the year 1894, 14,000 roof fixtures of all kinds in that portion of the City of Boston north of Dover and Berkeley Streets.

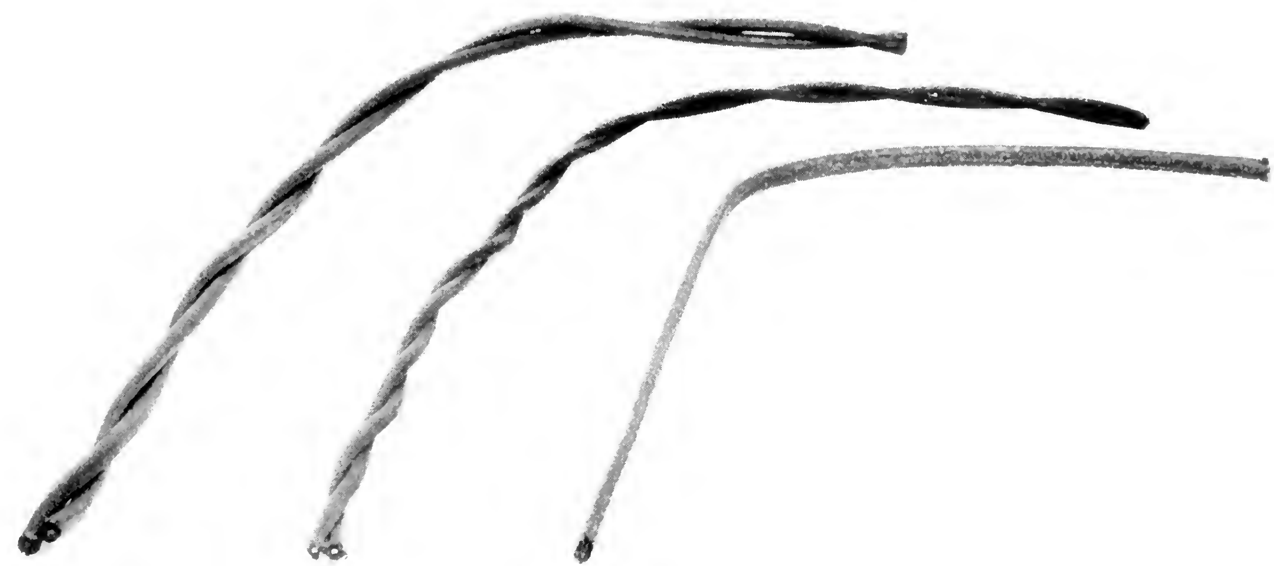

FIGURE 2. THREE STAGES IN THE DEVELOPMENT OF DROP WIRE USED IN THE BELL SYSTEM.

Left: No. 14 B. & S. gauge hard drawn copper twisted pair. Center: No. 17 B. & S. gauge bronze twisted pair. Right: No. 17 B. & S. gauge bronze parallel.

in contact caused them to work badly. Troublesome tree conditions were also encountered in other parts of the lines and it was thought that the leakage troubles could be avoided by using rubber insulated wires where tree contacting could not be avoided. In the early '90's several different kinds of wire were being experimented with, tending toward the unified practice of all-insulated wire drops, and in 1896 the American Bell Telephone Company issued specifications for hard and soft drawn copper wire with rubber insulation. They covered four sizes of wire, 165, 104, 080 and 064 (expressed in mils) and provided "when desired" for laying the wires "up in pairs, either twisted or straight." The year 1897 saw rubber aging tests being made in the American Bell laboratory at Boston. Climatic tests were also used, and comparisons were made between accelerated laboratory tests and the test of actual service.

The records indicate that twisted pair became an American Bell standard in 1901, coincident with the issuance of specifications for "Twisted Pair of Rubber Covered Hard Drawn Copper Wires, No. 16 B. W. G. (.065-inch diameter)." It was intended primarily for use through trees and it did not entirely supersede other types of drop wires.

In 1902 the specifications were revised and the gauge designation was changed from 16 B. W. G. (.065 inch) to 14 B. & S. G. (.064 inch). This wire, which was also hard drawn, became known as "14 twist" and it afforded such great improvements in service and handling properties over the several types of wires used previously that those who participated in its early use never ceased to venerate it. It still holds an exalted place in the minds of many pioneers who now occupy positions of all ranks in the Bell System and it would be almost sacrilege for one to deny that it was superlative wire. It may be said, however, that the knowledge of the properties of materials and rubber technology have been advanced during the last thirty years, so that although the early 14 twist may have been a superlative service wire, its present successor with certain other points to its credit needs no apologist. For one thing, it cost the Bell System during the last five years about $7,000,000 less than 14 twist would have cost. Although the use of 14 twist for drops was practically discontinued in 1910, it has continued to be used to a limited extent for various other purposes.

At about the time when 14 twist came into being, the common form of distribution was rapidly changing from the open wire type to the cable type, and this seems to have caused greater attention to be focused upon drop wire performance. Open wire lines through trees, of course, gave a great deal of trouble, and open wire drops, although an important source of trouble, were not conspicuous on this score; but when open wire lines were replaced by cable, the open wire drops were found to be the most important source of trouble. It was natural, therefore, that 14 twist should have been so cordially adopted. The trend from exchange open wire to cable distribution is disclosed by the following table of approximate wire mileages in the Bell System as at certain year ends:

Year	Miles of Exchange Aerial Wire Exclusive of Drop Wire		Ratio of Miles of Exchange Open Wire to Total Miles of Exchange Aerial Wire
	Open Wire	Wire in Aerial Cable	
1900	420,000	225,000	.65
1905	915,000	1,245,000	.42
1912	1,179,000	3,628,000	.25
1922	1,064,000	6,447,000	.14
1932	1,169,000	17,021,000	.06

Notes: Previous to the year 1911, the plant measurement reports at headquarters showed no separation of Total Miles of Exchange Aerial Wire between Open Wire and Wire in Aerial Cable. The figures of 420,000 and 915,000 miles are estimates.

The Open Wire figures for 1900 and 1905 include a small amount of covered wire along the lead which could not be separated out. The Open Wire figures for the other years are bare wire only. None of the Open Wire figures includes any drop wire.

The first successor to 14 twist for drops was 17 B. & S. G. copper-steel twisted pair, which was standardized in 1910, and this in turn was succeeded by 17 B. & S. G. bronze twisted pair in 1921. The insulated conductors of these types were separately braided and waxed before being twisted into pairs. The parallel type of wire in which two insulated conductors are covered by a common braid came into System-wide use in 1924. The present standard drop wire is of this type and consists of No. 17 bronze conductors which are coated with tin, insulated with rubber compound, and two such conductors sheathed with cotton braid which is saturated with a preservative and coated with weather and wear resisting pitch and flake mica. It is available with two types of braid covering, one being made of coarser, harder cotton yarn than the other so as to afford needed protection to the insulation against severe exposure to abrasion. This resistant braid wire, as it is called, costs more than the other, but its higher cost is more than compensated for by its greater endurance in the many cases where there is no alternative to running the wire through trees. Obviously, there are many more cases where the path of the drop is, at least relatively, free from obstructions and where the wire with the less resistant braid is the more economical one to use.

Three types of drop wire discussed in the preceding paragraphs are illustrated by Fig. 2. No. 17 B. & S. gauge copper-steel twisted pair had the same dimensions and the same appearance as the bronze pair shown in the center of the figure.

Aside from its physical properties, drop wire is a relatively short-lived part of the plant, being subjected to frequent changes associated with the station turnover and with any reconstruction of the open wire and cable plant, so that a vast amount of it is used year in and year out throughout the Bell System. The record shows that during the five years ending December, 1932, nearly 2000 million pair feet were installed.

The reasons that have led to one change after another in drop wires are, obviously, the need for wire that would be more resistant to destructive influences, and the desire for economy. Mention has been made of abrasion as a cause of drop wire trouble. It is responsible for more than one-third of the troubles. Development work has gone a long way toward preventing abrasion troubles on wire that has been installed during the last few years, and it is expected that, as the ratio of new type wire to old type wire increases, the relative number of abrasion troubles will diminish appreciably. Other injuries to insulation account for about one-sixth of the troubles. The crushing or shearing of the insulation at points of support or other pressure points is one of these and in this case also development effort has been well spent. Nearly one-half of all the troubles, however, are caused by storms, falling trees, motor vehicles, animals, people, and a wide variety of accidental events which can be affected but little by changing the properties of the wire; and the efforts to reduce such troubles, therefore, have been made in other directions.

Noteworthy Improvement of Rubber Insulation

Rubber compounds such as those used on drop wires throughout the last score or more years are inherently good insulators when new, but until a few years ago all of the compounds deteriorated rapidly, due to oxidation. The engineers of the Bell Telephone Laboratories attacked this problem of oxidation and after much experimenting made marked progress in solving it by developing insulating compounds containing certain substances known as anti-oxidants, which were being used to some extent in rubber tires. A generally accepted view as to the part played by anti-oxidants is that they function as inhibitors and by their presence in the rubber compound retard the normal oxidation or aging rate. They have the practical effect of greatly extending the useful life of the insulating compound.

New Testing Procedure Developed

In development work of this kind, which involves a selection of the best materials from a large number of possible choices, an essential part of the problem is the development of testing methods. In this case it was necessary to develop an accelerated aging process that would simulate the slow, natural aging of the compounds in the telephone plant, and also special testing equipment and procedures that would give a reliable indication of the vital qualities of the wire, both when new and after accelerated and natural aging. Otherwise, many years would have elapsed before a proper choice could be made and before there could be definite assurance that some detrimental features had not crept in. A quick aging process had already been developed for certain uses in the rubber industry, and this was adapted to drop wire. As in the older work, this recent work followed the formula established in the old Boston laboratory in 1897 of making climatic tests and comparisons between the rapid test and the test of time. A new type of testing machine was also developed to measure the compressive strength of rubber insulation. This machine and the rapid aging process put rubber insulation on a far better basis than it had ever been and this resulted almost immediately in marked improvement in the quality of drop wire insulation. The compressive strength of the insulation as now manufactured is at least twice that of new wire only six years ago, and after aging the equivalent of three or four years in the plant the comparison favors the present wire by a ratio of about 5 to 1. This means that the present wire should be better when it is three or four years old than was new wire six years ago, and it indicates a long useful life for the present wire. When rubber compound of the general type under discussion has greater compressive strength it also has greater toughness, which means greater ability to endure the kinds of abuse to which drop wire is ordinarily exposed.

Improved Protective Covering

Even though the insulating compound has been much improved, it still needs further protection against its worst enemies: rubbing tree limbs, and sunlight. The means for accomplishing this is to enclose it in a lightproof covering that will resist abrasion and withstand a wide variety of weather conditions. For many years the covering has consisted of a

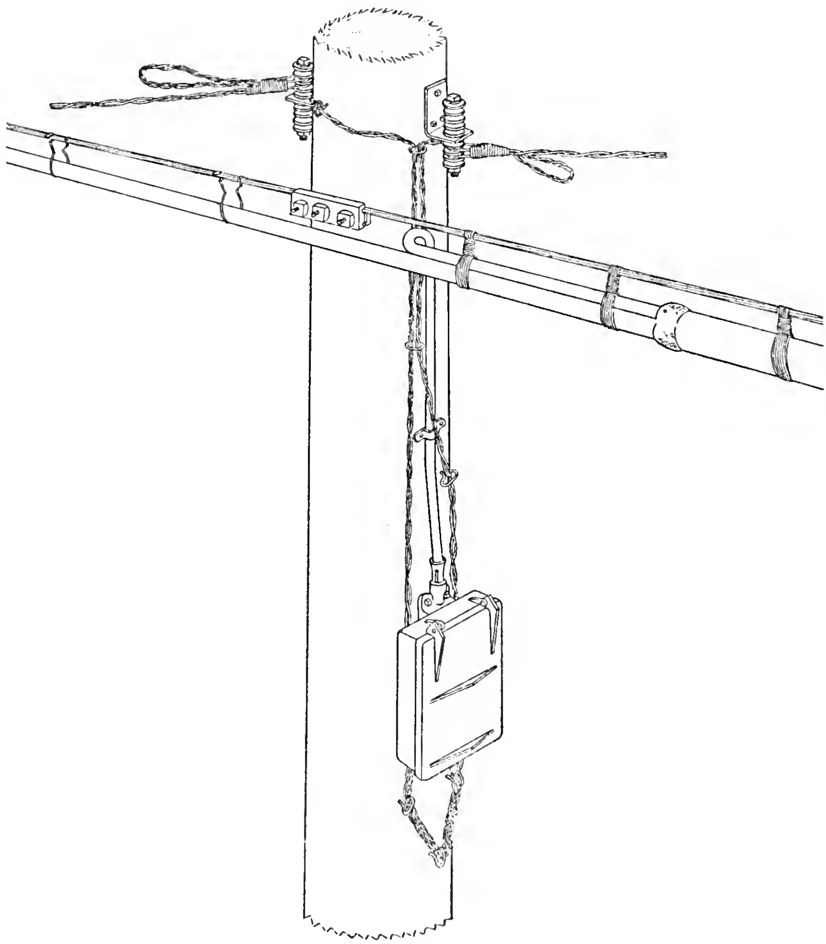

FIGURE 3. DISTRIBUTION FROM AERIAL CABLE TERMINAL ILLUSTRATING THE USE OF TWISTED PAIR DROP WIRE AND DEAD END TIES (NO. 14 TYPE CABLE TERMINAL).

cotton yarn braid which has been treated with weatherproofing materials. These materials and the methods of applying them have undergone a number of changes throughout the years but, similar to the experiences with insulating compounds, quantitative measurements of results had to come before there could be definitely predictable improvements in serviceability. To

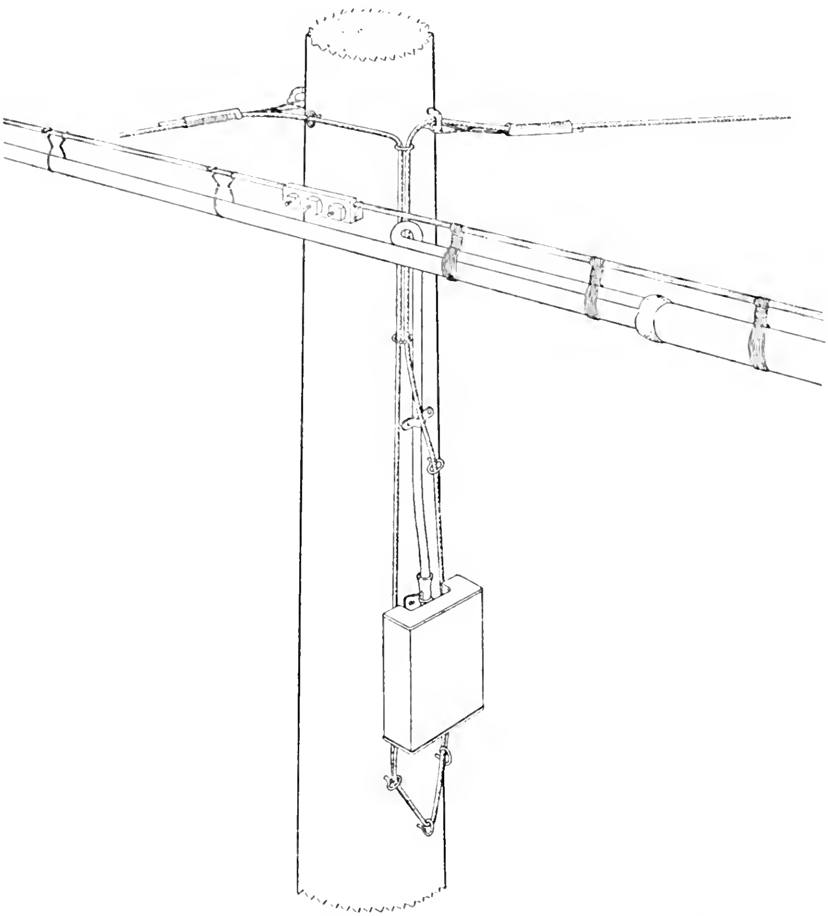

Figure 4. Distribution from Aerial Cable Terminal Illustrating the Use of Parallel Drop Wire and Attachments (F Type Cable Terminal).

this end certain weatherometer and rubbing tests were developed in the Bell Laboratories and by their aid a new system of treatment of the braid was developed which will effect an important extension to the life of the braid and should improve abrasion resistance as much as five to tenfold.

Conclusion

Only the most important aspects of the rôle of drop wire proper are discussed in the foregoing and, therefore, it should be stated that the solution to the general drop wire problem has not depended wholly upon improvements in the wire. The means for holding the wire in suspension and for terminating it have always been important features and a large amount of work has been done toward perfecting them. It is not the present purpose to discuss that work, but it may be said that these attaching means have also been developed through many stages by which there has been achieved a more nearly trouble free and better looking drop structure. The trimness of parallel drop wire supported by its inconspicuous attachments makes a pleasing contrast with the old style drop with its bracket and looped tie. Figures 3 and 4 represent the appearance of typical terminations of old style and new style drops.

The many unwritten pages of the drop wire's history have in them much of the lives of an army of telephone people, who at times have found it an indispensable aid in restoring telephone service after disasters such as those caused by upheavals of nature, and who at other times have had their souls tried by its failure to surmount its handicaps of environment.

Despite the vicissitudes, however, which are inherent in its function, and which are greater than those of any other item of telephone plant, it has evolved step by step into more and more useful forms.

R. A. Haislip

Communication with Electrical Brains

A MOTORIST, warned by a red traffic light that his road will intersect a main highway, slows down for the crossing. No officer is in sight and the unattended signal still shows red. On his side of the road, a few yards from the highway, his car runs over a narrow ridge of rubber. As the rubber is depressed, his request for permission to cross the highway is transmitted to the mechanism of the traffic signal; a few seconds' delay and then its lights change; the stream of cars is halted and a green light authorizes him to proceed.

In this situation the various actions, the transmission of intelligence and the manifestations of authority, are the same as for a crossing guarded by an officer. The red and green lights replace, respectively, his raised hand and the jerk or wave of the other. The procedure has been standardized. All cars are treated alike and the waiting time is definite. Prejudice and whim have been eliminated, but with them judgment and initiative. There is a calm, consistent handling of the traffic—quite automatic, it is true. A mechanism has been established which receives communications from a human being and, in turn, initiates communications with others.

The operation is very simple. Two contacts, which act as a switch, are pressed together when a car passes over the rubber ridge. The current, which is thereby allowed to flow, energizes an electromagnet. This, in turn, with predetermined delay, moves the switches which change the lights. Another period of delay and the light switches return to their original positions; the cycle is complete.

The mechanism has none of the external characteristics of the robots and mechanical men which appear from time to time at fairs and expositions or are enthusiastically described in the popular press. Such contrivances are usually designed to perform mechanically, in response to proper stimuli, certain operations which are appropriate to humans. They are formed in the rough outlines of a man and may look like grotesque and ill-fitting suits of armour which have been fashioned by a pipesmith or sheet-iron worker. Or they may be as carefully modeled as a store window dummy and arranged to move arms and legs. Then they are valuable in window dressing and add some illusion to the scene in which they are placed. At its exhibit in the Chicago Exposition an air transport company used two such dummies in the cockpit of a large cargo-passenger plane. The life-like figures moved the controls and periodically one of them raised to its lips the telephone transmitter of the radio set with which such planes are equipped. As it did so a phonograph spoke words typical of the reports and instructions which a pilot would receive.

That would seem to be the *metier* of the mechanical man: to add reality to educational or advertising displays. When more is attempted, the canons of machine design as well as of art are usually violated. Mechanism loses dignity and effectiveness when forced into unnatural forms. An automobile could be built like a jinrikisha, with its motive power vested in a mechanical man, and the creature be no more illegitimate than is an iron-cheeked man constructed to inhale through lighted cigarettes which are properly placed in its lifeless lips. The traffic signal would gain nothing and cost more if made a biped.

In its case there is no need to ascribe to it any human abilities, neither cognition nor volition. It is an inanimate mechanism. But there may be something more in the situation. The device replaces a human being who would otherwise be present and with whom communication would be held. Two parties would normally be engaged at a guarded crossing: a motorist and an officer. Their necessary communication is limited in amount and is not specific as to medium: words, gestures, meaningless sounds, or displays of lights will serve. Nevertheless, there is communication. The motorist asks and the officer grants. The latter's cold indifference to impatience on the part of the driver is as definite a refusal as can be expressed in words, and its counterpart in the mechanical system is the steady red light. So far as the motorist is concerned, there is communication—an actual exchange of information. The transmission is two-way, like that of a conversation and unlike the one-way operation of a radio broadcast.

A generally recognized difference between our present civilization and those stages which have preceded is due to the increased speed of transportation, whether of ideas, of goods, or of men. For ideas, if the intelligence is recorded as in letters or must be delivered by a particular person, transportation can take place only at the speeds of miles per hour which are usual for goods and men. When the intelligence can be carried by an electrical wave, its speed may be thousands of miles a second, or even as fast as light. Not only do electrical systems for communication possess this possibility of enormous speed, but also they offer the most convenient medium when the terminals happen to be remote either because of actual distance or because of inaccessibility.

The simplest communication system is that of the early telegraph. In it there is a battery from which current can flow when, and as long as, a key is depressed. This source of current and its controlling key are connected by a pair of wires with the distant terminal; and there, when the current flows, it actuates an electromagnet which moves a lever. It was the clack of this lever striking against metal stops, which limited its motion, that Morse used as an audible signal, which by proper coding could represent letters.

The lever, of course, may perform entirely different services, moving anything which is light enough. In general, the lever is used to close another switch contact which controls a local source of power of generous proportions, sufficient to operate a larger electromagnet or to run a motor. The electromagnet and its lever, which can make or break an electrical connection, is an electrically operated switch. As such, since it can be controlled from a distance, it becomes an immensely important element in all communication systems and in all instances where a remote control of mechanisms is desired. The device is conveniently known as a "relay."

The relay is an essential element whenever there is communication between man and machine. In such exchange of information the mechanical participant will be found to be a more or less complicated assembly of electrical equipment. The complexity will be due not to the variety of elements, for there are not over a dozen different kinds of elements, but to their interrelation. Just as in a clock movement sequences of operations are established by trains of small gear wheels, so electrical mechanisms are built up by a succession of electrical circuits which mesh or link together. Each circuit, in itself, is as simple as that of the telegraph which was described earlier, or of a doorbell with its battery, bell, connecting wire and push-button switch. Each includes some source of energy—a battery or a power main. And the relay is the point of contact between the various links—the means through which one circuit controls the next.

Relays may be constructed and arranged to perform almost any conceivable operation of closing and opening circuits. In the typical construction, the controlling current passes through a coil of wire which incloses a core of magnetizable material. The resulting magnetism, when current flows, attracts an iron lever, the armature. This armature is moved against the pull of a spring which restores it to its unoperated position when the current ceases to flow. The armature itself usually serves as the movable member of the switch which the relay is to operate. Obviously, then, its motion will close or open a switch, depending upon the position of the fixed member. In general, also, relays are constructed so that the armature in its motion pushes before it several leaves, each carrying its separate contact point. The leaves, which are flat springy strips of metal, and the armature are all insulated from each other. A number of separate switches are thereby formed; and switching in several independent circuits can be accomplished under the control of the current in the winding of a single relay.

Because of this construction, the device has amazing adaptability in the design of electrical mechanisms. The spring leaves may be assembled to execute in rapid succession a dozen or so independent operations of switching. Also, it is not necessary that these shall be undone when the controlling current ceases, for a relay may be made to lock so that a mere pulse of current, lasting long enough to move the armature, will make changes in other circuits which will persist until some new stimulus, in the form of current, arrives to break the lock.

When this is desired, two similar coils may be wound on the magnetic core. Current in either will keep the lever displaced. One coil is used for the control current and the other for a current which locks. The latter is supplied from a battery, connection with which is made through a pair of contacts operated by the armature. When the controlling current flows, it moves the armature, making or breaking the various contacts which the relay is intended to operate but, at the same time, closing the contacts which supply current to the second coil. The relay, therefore, locks. For its unlocking, in the circuit of the second winding, a pair of contacts must be provided which will open under the action of another relay. Current supplied to this relay will then allow the armature of the first relay to spring back, undoing all its previous accomplishments.

If there is any justification for ascribing human qualities to mechanisms, it arises from the potentialities of this simple contrivance. A stimulus arriving at a human brain may result in an instinctive action, releasing for that purpose certain available energies. That is precisely what a relay does. Unthinking, unreasoning, and instinctive, each relay of a communication system performs its definite and predetermined task in response to controlling pulses, wherever they may originate

A whole sequence of actions may be set off, delays introduced as desired, and action may be limited to the duration of the pulse or steadily continued until stopped by a new stimulus. One relay may control a circuit in which there is a second relay, that in turn a circuit with a third, and so on in an infinite variety of combinations. Each relay in the series, while so doing, may function as the original of a new series; and any of all these branching series may contain motors and electromagnets to turn or push or pull, exerting forces on their surroundings. It is, then, not so inconceivable, although the project would be futile and eminently unpractical, that by the proper assembly of relays there could be constructed electrical equivalents of human brains.

The nearest approach to an electrical brain, that there has as yet been practical occasion for constructing, is the so-called "sender" in the central office of dial telephone systems. The number of mental operations which this sender must perform within itself, and the further number which it must accomplish externally, demand a tremendous assembly of relays. Its designers also developed a mechanism which acts like a whole gang of relays. The device, descriptively named a "sequence switch," can coördinate a complicated series of operations, making them simultaneous when desired or introducing any necessary interval; and any of the operations may be arranged to repeat itself periodically, like the cry of a human baby, until conditions permit its satisfaction.

In a sequence switch, the two terminals of the circuit which are to be joined are thin strips of metal, so-called "brushes," and rest on a plate of insulating material. If, as the plate moves, a strip of metal mounted on its surface is brought simultaneously under both terminals (i.e. brushes) then the operation of switching is accomplished and the circuit remains closed as long as the motion of the plate does not carry the connecting strip beyond contact with either brush. The plates, which are circular and flat, can be mounted in considerable number on a common shaft and thus all travel at the same speed. A succession of switching operations may thereby be precisely arranged for a large number of electrical circuits. The shaft is usually driven by a motor to which it connects through a clutch; and the operation of the clutch, in its turn, is controlled through relay contacts.

These switches are simple structures, compact and reliable, and economically produced in large quantities. With relays they constitute the elements of which designers have constructed electrical brains to act in establishing connections between dial telephones.

Arranging mechanisms to connect your telephone—if a dial type—to any other which you desire, in accordance with your dialing of its number, involves a surprising list of difficult and intricate problems of circuit design. Only one of these is of immediate interest. Assume, therefore, that in response to your lifting of the receiver, your telephone line is connected, at the central office where it terminates, with the mechanism which is to find the terminals of the line you wish. How that mechanism became connected to your line; how, like an operator's "number please?," it sent you a tone to indicate its readiness for your instruction; and all the other how's are momentarily disregarded. You dial, usually what corresponds to two or three letters and four or five numerals. The letters, however, are merely mnemonic: each is equivalent to and replaceable by a numeral. The numerals indicate the number of interruptions in the current which their dialing occasions. For each interruption there is, in effect, a transmission from your telephone to your central office of a pulse or spurt of current. These pulses, by their operation of relays, are to select, first, trunk lines to the central office of the telephone you are calling, and, then, at that office, from the thousands of lines there terminating, the particular one you desire.

Two methods of operation are available. The first, which is usual when there are relatively few central offices in the area of your telephone exchange, involves no electrical brain. It is a step-by-step operation where some selecting mechanism moves once for the first pulse, makes another step for the second and so on, finally arriving at the one of the ten possible positions corresponding to the numeral you dialed. Another mechanism then takes up the task and performs as you dial. Your control of these distant mechanisms is remote, but as direct as your actions in setting the hands of your watch or shifting your automobile gear.

The other method simulates more closely those of ordinary telephony, where an operator receives your instructions and then proceeds to put them into effect. It is the one which engineering studies have indicated as better adapted to service in those metropolitan areas where there is congested the largest number of central offices.

It is such exchange areas which explain the practical necessity for the adoption of machine switching. Imagine yourself, for example, in an anonymous city which, with its immediate suburbs, has a million telephones. Divide these evenly into central offices each with ten thousand lines. There are then one hundred such offices. You may call a party in any of these, and your operator must know how to reach it. It is economically inefficient to provide trunks connecting your office directly with each of the other ninety-nine; and each of those, similarly, with all the others. Some offices must be reached through others.

However it is all arranged, there will be required at an operator's position an array of equipment, almost bewildering in its amount, from which she must select the appropriate keys for signaling to the distant central office to which your call is directed. How far she can reach to right or left, and how high, limits the amount of equipment she can handle; and the complexity from which she is to select must not exceed that with which she can deal promptly and accurately. Such mental and physical limitations years ago indicated an approaching day when many of the switching operations of telephony would of necessity be mechanically performed.

No less human effort might be required in the total, but it would be expended first in design and development, next in manufacture and installation, and thereafter in the maintenance of immense and complicated aggregates of equipment. Years of invention and test produced the "panel system," with its electrical brain. Such work, however, is never complete, for new requirements arise, and opportunities for improvement and increased economy always attract the engineering mind; so the development work continues unslackened.

In the panel system for dial telephony—which is so-called because the terminals of lines and trunks are arranged in large vertical panels—the electrical brain replaces in typical functions that of a human operator. Unlike the step-by-step system, the selection of the desired line is not made directly under your remote control as you dial. Instead, the instructions involved in your act of dialing are recorded, within the equipment of the electrical brain, in a set of circuit conditions which are established by the pulses you dial. This corresponds in function, although obviously not in mechanism, to recording in the brain of an operator.

On the basis of those instructions, now comprehended as a whole, the electrical brain then proceeds. First it must determine how to route that particular call. In the telephonically congested areas where the panel system is employed, the traffic information is too voluminous for prompt guidance of human action; and if an operator handled the call she might have to consult a card of instructions. That, similarly, the electrical brain must do. For a fraction of a second, therefore, it connects itself to an electrical equivalent of an operator's traffic manual. In that instant certain of its relays are operated, its internal circuit conditions are correspondingly changed, its mind is now clear and it knows what to do. It then proceeds by relay and sequence switch to actuate equipment, first in its own central office and then in one or more distant offices, which will make the selection of line terminals required to complete your call.

In response to stimuli from the electrical brain, a sequence of selection is made, first of trunk line to the proper central office and there of successively smaller groups of lines until the final selection of the particular line. These actions differ from those performed in step-by-step systems in a way which illustrates also the mental attitude of the electrical brain.

In both cases, selection is accomplished by some moving member which carries one end of a pair of conductors, the other end of which connects to your line. When its motion has brought it to the right trunk or line, it stops and connection is made. The moving member, conveniently known as a "selector," is pushed ahead in the step-by-step system one position for each pulse, stopping when the pulses cease.

In the panel system the electrical brain throws in a clutch, just as a motorist engages his engine, which starts the motion of the selector. This continues steadily until the brain stops it by throwing out the clutch. The interesting mental action is that involved in determining when to disengage the clutch and let the selector stop and make its connection. It is arranged that, as the selector reaches successively each of its possible stopping points, it shall notify the brain of its arrival. The brain then keeps track of its progress and, when the selector arrives at the desired point, stops it. The process is similar to that in train dispatching when a train is sent along a track and its conductor at each way station reports his arrival; at the proper station he is then ordered to take the siding.

Only two have been described of the several functions of the electrical brain in panel-type dial systems. For each telephone call, hundreds of operations are required. These tasks the brain must perform accurately and with more than human reliability. If it fails, it must immediately be removed from service; and, because such devices are expensive, it should be promptly inspected, readjusted, and returned to service. In the more recently designed forms, therefore, new cerebral functions are being provided.

Should one of these devices fail—incidentally, they are known as "decoder senders"—it will, of its own action, disconnect itself from the line of the subscriber whom it is answering and report to a maintenance man. Even more: for his information it will print on an electrical typewriter the number of the operation at which it failed. Could more human intelligence and efficiency be demanded of any organism than that it should quit work when diminished powers endanger its further acts, call for help, and accurately state its symptoms for diagnosis?

John Mills

Editor's Note: The article above is a chapter of a book, "Signals and Speech in Electrical Communication," which is announced for early publication.

A Census Portrayal of the American Family

IN the marketing of household commodities and utilities in any area, the group of persons comprising the family is often considered the fundamental population unit on which to base estimates of potential sales of goods and services for the home. In the general type of population problem usually encountered in Bell System studies, the family is perhaps more significant than the individual, particularly in measuring the residence market and in calculating the degree of penetration of this market realized by the telephone industry. Therefore, a thorough understanding of the composition and characteristics of the average American family, as well as a knowledge of the number and distribution of total families, as shown by available Federal Census data, are essential in any comprehensive population study or market survey.[1]

Composition of the Family

In the 1930 census returns, the term "family" is limited in the main to so-called private families, excluding economic or quasi-family groups—institutions, hotels, boarding houses, etc.—which had been counted as families in previous censuses. The elimination of the institutions and other quasi-family groups makes the reported "family" more representative of the typical domestic household, for while the average number of persons per private family in 1930 was four, the corresponding size of the economic family was nearly ten times as large.

Average Size of Family

The number of private families in the United States on April 1, 1930, was slightly in excess of 29,900,000, while the

[1] The plan of the Census Bureau provided for the collection and tabulation of family data in 1930 on a much more pretentious scale than had ever before been undertaken. Revised definitions and classifications, together with several new inquiries of interest, were introduced; and these changes have definitely improved the usefulness of the census statistics on families.

quasi-family groups totaled about 75,000, an aggregate of nearly 30,000,000 and an increase since January 1, 1920, of 23.1 per cent. This increase is considerably in excess of the reported rate of population growth (16.1 per cent) during this ten-year period—a circumstance which is explained by the very substantial decline in the size of the average family.

The American family has diminished steadily in size for several decades, the average population per family including institutions, etc., having dropped from 4.9 in 1890 to 4.1 in 1930.[2] The corresponding change in the average size of the private family has more real significance; but private families were counted separately only once prior to the recent census (viz., in 1900) and then on a slightly different basis. However, the indicated reduction in the average population per private family from 4.6 persons in 1900 to 4.0 persons in 1930 is accurate enough to be reasonably representative of the decline in the average size of such families. Decade by decade, changes in the size of the private family cannot be gauged exactly, but a clue to what may have been happening in the period between 1900 and 1930 can be gained from recorded changes in the average size of all families, including economic as well as private families.

Population and Families for the United States

	1930	1920	1910	1900
Population				
Total	122,775,046	105,710,620	91,972,266	75,994,575
In private families only	119,812,185	—	—	73,410,992
Families				
All families	29,979,841	24,351,676	20,255,555	16,187,715
Private families only	29,904,663	—	—	15,963,965
Population per Family				
All family groups	4.10	4.34	4.54	4.69
Per private family	4.01	—	—	4.60

[2] The average size of a family is usually expressed fractionally, as for example 4.35 persons per family, when what is really meant is that there are 435 persons per 100 families.

The considerable decline in the average size of family, as indicated in the accompanying table, may be divided into two parts: a decrease in the number of adults per family and a decrease in the number of children per family. The former factor declined from 2.61 to 2.51, or about 3.8 per cent, in the three decades, while the latter ratio dropped from 2.08 to 1.59, or 23.6 per cent. Expressed in different terms, only one-sixth of the total decline in the average size of family was due to factors affecting the number of adults per family, such as limited space in urban multi-family dwellings, the decrease in the number of domestic servants, and improved household facilities which have made it possible for old people to live by themselves; while five-sixths was due to the marked reduction in birth rates.

Many of the influences tending to lower the size of the family are more characteristic of urban than of rural areas. The average population per private family in cities having 25,000 or more inhabitants, 3.75 persons, was less than that in the rest of the country, 4.19 persons. The corresponding sizes of the quasi-families were 36.2 and 43.6 persons respectively, which seems to establish the fact that all families, whether private or economic, are smaller in the large urban centers than in the small cities and country districts. Consequently, the increased proportion of the population living in cities explains to a large extent the decline in the size of the family.

Regional differences, too, are important, as the rapidly growing regions—especially those receiving large influxes of migrants from other areas—have relatively small families, while those losing by interstate migrations have relatively large families. Thus the Pacific Coast region, the population of which includes many people who have retired from business, has the smallest average sized family, 3.4 persons, and the South Atlantic States the largest, 4.4 persons, a difference of an entire unit. In fact, the average family in the Southern States is much larger than that in other regions; while this is not notably true in southern cities, it is strikingly so on southern farms. The families on the Pacific Coast are smaller both in urban communities and on farms than in other sections of the country.

For the first time, the 1930 Census gives data on the "kinship" family, which is a group related by blood, marriage or adoption and living in the same household. It differs from the private family by the elimination of lodgers, resident servants, guests, and foster children or wards. The most common size of kinship family was two persons, this group constituting 23.4 per cent of the whole number of such families, while three-person families formed 20.8 per cent of the total and four-person families 17.5 per cent.

The average size of kinship families was 3.81, but this average varied considerably between areas and racial groups. The urban family was about 18 per cent smaller than the farm family in 1930, the average sizes being 3.6 and 4.4, respectively, while the rural non-farm family average size was 3.7. As to variations by race, the average size of the native white family, 3.73, was smallest, followed by the Negro family with 3.81. The foreign-born white family was considerably larger than these two groups, with 4.08 average size, in spite of the fact that the great majority of these families were located in large urban centers. These variations in size between the racial groups reflect in part the differentials in their birth rates and in part the differences in their living standards.

Children in Families

In 1930 nearly 59 per cent of all families had no children under 10 years of age, while 39 per cent had no children under 21 years of age living at home. That is, 3 out of 5 homes were free from the confining cares of any young children (under 10), while 2 out of 5 families had no responsibilities for any children under 21 living at home. A considerable proportion of families, of course, consisted of elderly persons whose children had grown up and left the family, or were at least 10 years of age.

On the other hand, one-fifth of all families had one child under 21 years of age living at home and one-sixth had two children, while one-fourth of the families had three or more children each.

There are striking differences between urban and rural families with respect to the number of children. Nearly two-thirds of all urban families had no children under 10 years old living at home in 1930; and on the farms one-half of the families did not have any children in this age group. The percentage of one-child families was slightly larger in urban than in rural territory, but for all groups reporting two or more children under 10 years old the proportion in the farming areas was much higher than in the urban, and somewhat higher than in the non-farm rural. Moreover, only one in ten urban families had as many as four children under 21 living at home, contrasted with about one in four farm families. These differences, of course, reflect the higher birth rate in the country as compared with the cities.

Color and Nativity

In the census reports, families are classified according to the color and nativity of the head of the family. In a family recorded as foreign-born white, the head is a foreign-born person; the wife may be either native or foreign-born, but the children, since most of them have been born in this country, are practically all native white. Consequently, the proportion of the population which is native-white in any area is usually much larger than the proportion of native-white families. And, conversely, the percentage of the families classified as foreign-born white is likely to be much larger than the percentage of population classified as foreign-born white.

Native white families are the most important group. constituting 70.1 per cent of the total number in 1930, while the corresponding percentages for the foreign-born white and negro classes were 19.2 and 9.4, respectively. Three-fourths of the native white families were of native parentage and accounted for over one-half of the total number of families. Since 1900 the proportion of native white families has increased markedly, while the relative importance of foreign-born white and negro families has declined appreciably. This development has tended to produce a more homogeneous market as regards nativity and racial characteristics, while the increased preponderance of native white families with their generally higher living standards has resulted in still further improving the sales prospects for utility services.

Economic Status of the Family

Certain economic characteristics of the population are revealed by the census classification of private families according to the number of gainful workers, the employment status of the homemaker, and the number of lodgers or boarders. Furthermore, some indication as to the extent of the top grade residence market is provided by the census returns showing the number of families having servants living in the home.

Gainful Workers

One of the chief factors affecting the household income is the number of employed persons per family. In the classification of families according to the number of gainful workers, all related members of the family who were reported as usually working at a gainful occupation were counted, including some who were temporarily unemployed at the date of the census. In general, it may be said that the number of gainful workers included those persons who were presumably contributing to the family income.

The census reports indicate that in 1930 five out of eight families had only one gainful worker, while one-fifth of all families had two members employed. On the other hand, 6 per cent of all families reported no gainful worker in 1930, representing mainly the families of widows and of elderly men who had retired from active employment. Families with no gainful workers were most numerous in urban areas, but were proportionally highest in non-farm rural territory (10.4 per cent) and lowest on the farms (1.8 per cent). Moreover, they were relatively twice as numerous among families owning homes as in families renting homes.

Over 3,200,000 families, or 10.8 per cent of the total number in the United States in 1930, reported having three or more gainful workers. In this connection some allowance should be made in certain areas for the fact that many of the gainful workers were members of the family working without wages on the homestead. This was particularly true among the farm population of the South, where in several states one-fifth of all farm families had three or more members employed. While those persons were contributing to the family income, their status was not quite the same as that of persons working for outside employers for wages.

Homemaker by Employment Status

While the absence of children from the home releases the time of the mother from many homemaking duties and gives her freedom for social and recreational activities, it also offers the opportunity for outside employment, especially in the cities. The census reports include information as to whether the homemaker—designated as that woman member of the family who is responsible for the care of the home and family—pursued a gainful occupation in addition to her household duties. Nearly 4,000,000 homemakers, or one out of seven, were thus employed in 1930, and four-fifths of this number were employed away from home. Over one-half of those employed at home were engaged in agricultural occupations. The largest group of those employed on work away from home were in the service industries (30.4 per cent); the second largest group was classified as "industrial workers" (23.4 per cent); and the third largest as office workers (15.9 per cent). In view of the concentration of employment in activities which predominate in city life, it is not surprising to find that in the urban area in 1930 one in every six families had its homemaker employed for remuneration at other tasks than household duties at home.

Families Having Lodgers or Servants

The number of families having lodgers or servants may be significant as indicative of certain economic characteristics of the population. In 1930, nearly 5,000,000 lodgers or boarders were included in the households of about 3,000,000 private families, which in broad terms means that one in every ten families had one or more lodgers. In the classification of families according to the number of lodgers, certain other persons besides those directly reported as lodgers or boarders were included, among whom the most important group consisted of farm laborers living with the farm family. This involved a fine distinction between lodger and servant, the controlling consideration apparently depending upon whether or not the work was done outdoors or inside the home.

The proportion of families with lodgers was distinctly higher in urban than in rural areas, and was greater among tenant families than among owner families. As a class, tenant families probably are more likely to supplement their income by taking lodgers than are families who own their homes; and the best opportunities for renting rooms are in the cities where the largest proportion of unmarried workers is employed.

Certain information regarding the number of families having servants living in the home was obtained in the census as a by-product of the tabulation of families by number of lodgers. Only those families were included that reported no lodgers. On this basis slightly over 500,000 families had servants living in the home in 1930; two-thirds of this number were owner families, while 72 per cent were urban families. But because of the arbitrary definition of a farm laborer as a lodger, the published figures on servants in rural families are not directly comparable with urban data.

Dwellings

In telephone market studies the dwelling in which a family resides has been considered representative of its economic status, its standard of living and its purchasing habits. The latest census includes more information regarding the classification of dwellings by type of occupancy, the tenure and valuation of homes, and the proprietorship of homes by age of head of family than has previously been available. Probably one of the most important new features introduced is the classification of all non-farm homes according to the value of the home, if it was owned, or the monthly rent paid, if it was rented. These data permit a more accurate and comprehensive appraisal of the residence market than has hitherto been possible.

Classification of Dwellings by Occupancy

Household duties and the rearing of children are oftentimes much affected by the type of dwelling a family occupies, since wide differences in living conditions exist between single-family residences and multi-family dwellings. In 1930 all dwellings were classified for the first time into three groups, namely, those occupied by (1) one family only, (2) two families, and (3) three or more families. Apartment and tenement buildings form a large part of the last class, except in those areas where three-family houses are common.

Of the approximately 25,000,000 dwellings in the United States in 1930, slightly over 90 per cent were single-family residences, while 7 per cent were two-family houses and the remainder were of the multi-family type. One-family homes predominated in the rural areas, while double and multi-family dwellings were found principally in the cities. In fact, 3 out of every 8 families in the urban communities in 1930 lived in apartments or flats. Apartment dwelling is closely related to the increasing mobility of families, for few of such dwellings are owned by the families living in them.

Between 1900 and 1930 the excess of families over occupied dwellings increased by nearly 3,000,000, resulting in an increase in the ratio of families per dwelling from 1.12 at the close of the last century to 1.19 in 1930. This excess of families over dwellings is most pronounced in the northeastern section of the country, where the population is living largely under urban conditions with considerable concentration of families in multi-family dwellings. However, the increase of multi-family dwellings has as yet had little effect on average conditions throughout the country, for in 1930 76.4 per cent of all American families lived in one-family dwellings, and in the rural area the proportion amounted to 94.4 per cent.

Ownership and Valuation of Homes

Closely associated with the classification of dwellings by type of occupancy is the classification of homes by tenure, whether owned or rented. Slightly over one-half of all homes (about 51 per cent) were rented in 1930; in 1900 the situation was about the same.

While the total number of owned homes nearly doubled between 1900 and 1930, the owned farm homes actually declined numerically, a decrease of over 300,000 occurring during the past census decade, due to the many changes that have taken place in the agricultural situation in that period. During this period the owned non-farm homes tripled in number and increased from 35 per cent of the total homes in 1900 to 45 per cent in 1930.

More significant than the mere differentiation between owners and tenants as character indices of the residential market are the values of owned homes and the monthly rentals of rented homes. The values and rentals of non-farm homes have been assembled in 10 groups and this grading makes possible a classification of families according to economic status, or, perhaps more literally, according to purchasing power. In fact, the figures for home values and rentals provide a fairly sound basis for comparisons of family incomes by cities or by regions. Whereas the value of the figures for determining the absolute level of incomes is slight, due to the shrinkage in realty values everywhere since the census was taken, their usefulness for indicating relative conditions remains almost undiminished.

NON-FARM HOMES BY VALUE AND MONTHLY RENTAL
FOR THE UNITED STATES: 1930

Owned Homes			Rented Homes		
Value	Number	Per Cent	Monthly Rental	Number	Per Cent
Value under $1,000...	794,724	7.6	Rental under $10..	1,563,952	12.7
$ 1,000 to 1,499...	570,047	5.4	$10 to 14..	1,330,927	10.8
1,500 to 1,999...	531,277	5.1	15 to 19..	1,302,387	10.5
2,000 to 2,999...	1,167,325	11.1	20 to 29..	2,545,208	20.6
3,000 to 4,999...	2,343,769	22.3	30 to 49..	3,191,435	25.8
5,000 to 7,499...	2,297,029	21.9	50 to 74..	1,503,401	12.2
7,500 to 9,999...	989,468	9.4	75 to 99..	343,071	2.8
10,000 to 14,999...	906,557	8.6	100 to 149..	163,292	1.3
15,000 to 19,999...	339,535	3.2	150 to 199..	46,297	0.4
20,000 and over...	354,337	3.4	200 and over.	45,750	0.4
Not reported......	209,318	2.0	Not reported	315,829	2.5
Total..........	10,503,386	100.0	Total.....	12,351,549	100.0

In order to place owned homes on a comparable basis with rented homes and thus obtain the total number of families in any area that fall within the limits of a given income bracket, it is probably reasonable to apply the theory that one month's rent approximates 1 per cent. of the total value of a property. Thus, the owned homes valued from $5,000 to $7,500 could be combined with the homes having a monthly rental from $50 to $75 to obtain the total families in the income class represented by that rental group.

The median value of all owned non-farm homes in the United States in 1930 was $4,778, ranging from $7,500 in New York to under $1,000 in New Mexico; while the median monthly rental of all rented non-farm homes was $27.15, ranging from

$42.00 in New York to less than $10.00 in Alabama, Mississippi, and South Carolina. When broad geographical differences are considered, it is found that home values were generally higher in cities than in rural areas, and were lower in Southern States, both urban and rural, than in other parts of the country, with the exception of some of the Mountain States.

Tenure of Home by Age of Head of Family

As might be expected, the smallest proportion of owned homes in 1930 was reported for the proprietors in the youngest age group, with the proportion of owners increasing in each age group up to the highest. Conversely, the proportion of rented homes was largest among the youngest proprietors, and was lower in each succeeding age group. In view of the increasing proportion of home owners in successively older groups of heads of families, the apparent slight increase in home ownership between 1900 and 1930 may be fully explained by the higher average age of the population at the latter date.

Over one-half (54.6 per cent) of all men aged 65 years or more were reported as home owners in 1930. Even in urban territory, where tenancy in all age groups was most pronounced, 49 per cent of all men 65 years of age and over were classed as homeowners, while in the rural areas the proportion was materially higher, especially on the farms. But these percentages do not represent the complete economic story regarding home ownership in the upper ages. Many elderly men of independent means had their married children living with them and consequently did not appear as heads of families. This situation is well illustrated by conditions among the farm population. Over 500,000 farm tenants, or one-fifth of the total number in the United States in 1930, were closely related to their landlords. Presumably, many of these landlords were in the upper age groups and might not appear as heads of families or home owners because they lived with relatives or friends, or perhaps even in rented quarters. Under conditions where perhaps as many as two-thirds of all men aged 65 years or more are property owners, the common conception of a high degree of dependency among old men may need to be modified.

Summary

In any appraisal of the residential market, it is possible to distinguish certain inherent differences in the composition of the principal population classes. Fundamental variations in family characteristics exist between nativity and racial groups, between owner and tenant families, between urban and rural classes and between the several regions of the country.

In the percentage distribution of families by age and nativity of the head of the family in 1930, the average age appeared considerably higher for the foreign-born white than for the native white class. This is largely explained by the fact that the heavy immigration of aliens occurred 16 to 29 years prior to the 1930 census. These considerable acquisitions of foreign-born in the past are reflected in the increasing number of native whites of foreign or mixed parentage, even though the foreign-born population declined numerically during the past census decade.

Because restricted immigration since 1914 has altered the normal age distribution of the foreign-born in relation to total population and, furthermore, because four-fifths of all foreign-born families live in urban areas, a direct comparison of the characteristics of native white with foreign-born white families on an over-all basis is not significant. However, considering urban territory only, it is significant that the percentage of home ownership in every age group is uniformly higher for native white heads of families than for the foreign-born white. Another significant difference in family characteristics between nativity classes is shown in the data relating to the occupations of the gainfully employed homemakers. The great bulk of the homemakers employed away from home who were reported as professional and office workers and as saleswomen were native whites, while the foreign-born white homemakers were employed principally as industrial workers and as servants.

There is no doubt that, from the economic standpoint, the colored races constitute the poorest section of the market when compared with the other classes, especially the native white. This is reflected in the comparatively low degree of home ownership (25 per cent) among the colored races, in the low median value of owned non-farm homes and the low median rental of rented non-farm homes, in the relatively greater proportion of families having lodgers and in the much higher percentage of families with homemakers gainfully employed, principally as servants away from home and as agricultural workers on the home farm.

In general, private families are smaller in urban than in rural areas, especially in the farm areas, due principally to fewer children. This may be associated with the fact that single family residences predominate in the rural districts, while duplex and multi-family dwellings are chiefly characteristic of city life. In this connection, it should be noted that the median values and rentals of non-farm homes were distinctly higher in urban than in rural territory in 1930.

Additional indexes of general market characteristics show that the proportion of families with lodgers and of families having their homemaker gainfully employed was distinctly higher in urban than in rural areas, and was greater among renters than among homeowners. Also, as might be expected, families with servants were relatively more numerous in the cities than in the country, and also more numerous among homeowners than among tenants.

The general basic differences in the characteristics of American families described above are important factors when studying the potential market for residence telephone service; and they should be carefully considered when attempting to appraise the sales possibilities in any community or region.

R. L. Tomblen

BELL TELEPHONE QUARTERLY

VOL. XIII | APRIL, 1934 | NO. 2

NETWORK BROADCASTING

I. Historical Summary

II. Operating the Networks

III. Telephone Facilities

TEAMWORK AT ANDERSON, INDIANA

OWNERS OF THE BELL SYSTEM

INTERNATIONAL RADIO TELEPHONE CIRCUITS

AMERICAN TELEPHONE & TELEGRAPH CO. • NEW YORK

Bell Telephone Quarterly

A Medium of Suggestion and a Record of Progress

CONTENTS FOR APRIL 1934

PAGE

Network Broadcasting

I. Historical Summary—*R. T. Barrett* 75

II. Operating the Networks—*E. V. Wallace* 98

III. Telephone Facilities—*G. S. Bibbins* 106

Teamwork at Anderson, Indiana—*Vance Oathout* 113

Owners of the Bell System—*C. S. Van Cise* 128

International Radio Telephone Circuits—*Elam Miller* 142

Notes on Recent Occurrences 150

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INFORMATION DEPARTMENT
AMERICAN TELEPHONE AND TELEGRAPH COMPANY
195 Broadway, New York

CONTRIBUTORS TO THIS ISSUE

R. T. BARRETT

Lafayette College, B.A., 1907; New York Law School, LL.B., 1909. Engaged in practice of law, 1909–1918, and in newspaper work until 1921, when he entered Information Department, American Telephone and Telegraph Company. Mr. Barrett has contributed occasional articles to the BELL TELEPHONE QUARTERLY.

E. V. WALLACE

Georgia School of Technology, B.S. in Electrical Engineering, 1922. Long Lines Department, American Telephone and Telegraph Company, 1923–. After varied experience in Atlanta, Ga., Birmingham, Ala., and Nashville, Tenn., Mr. Wallace entered the General Plant Manager's office of the Long Lines Department in New York in 1928, where he is now Program Transmission Supervisor.

G. S. BIBBINS

Cornell University, E.E., 1924. Long Lines Department, American Telephone and Telegraph Company, 1924–. After varied experience in New York, N. Y., New Haven, Conn., and Boston, Mass., Mr. Bibbins entered the Engineering Department, Long Lines Department, in New York, in 1927, where he has since been chiefly concerned with Program Transmission Service.

VANCE OATHOUT

Plant and Commercial assignments, Iowa Telephone Company, 1903–1913. Northwestern Bell Telephone Company, Division Supervisor of Traffic, 1913–1916; Division Superintendent of Traffic, 1916–1925; Engineer of Plant Extensions, 1925–1927. Chief Engineer, Indiana Bell Telephone Company, 1927–.

C. S. VAN CISE

Williams College, B.A., 1914. New York Telephone Company, Accounting Department, 1914–1919. Bonbright and Company, bankers, New York, 1919–1920. American Telephone and Telegraph Company, Comptroller's Department, and later Treasury Department, 1921; Assistant Treasurer, 1923–; also Vice President, Bell Telephone Securities Company, 1929–.

ELAM MILLER

Pacific Telephone and Telegraph Company, Plant Engineering, 1902–1911; General Commercial Engineer, 1911–1912. American Telephone and Telegraph Company, 1912–. Since coming to New York, Mr. Miller has been engaged in various engineering capacities on the General Staff, and is now Staff Engineer.

A Section of the Telephone Company's Main Switching Office in Chicago. Here, in the course of a week, as many as 600 switching operations take place in routing radio programs, as explained in the article which begins on the opposite page.

Network Broadcasting

I. Historical Summary

EARLY in the development of radio telephony it became apparent that it was ideally suited for what might be called wholesale communication—that is, for the broadcasting of entertainment and of educational or informative matter. This type of communication was essentially new. Signal fires, columns of smoke, the beating of a drum or the blowing of a trumpet had been used, it is true, for the general dissemination of information, but with such exceptions as these practically all previous forms of communication—whether by sign, signal, written message, telegraph, wire telephony or otherwise—were intended for use in what may be called person-to-person or point-to-point transmission of intelligence. The first extensive experimentation in radio telephony was along the lines of its development for this form of communication—that is, for the transmission of the spoken word across oceans, to ships at sea or to other inaccessible points to which it was not then practicable to provide wires, cables or other physical conductors. As early as 1915, engineers of the Bell System conducted a series of experiments in which radio telephone transmission was achieved from the United States to such distant points as Paris, France, and Honolulu, Hawaii. Out of these early experiments have grown the far-reaching systems of radio telephone channels which now provide regular telephone service between the United States and half a hundred other countries on six continents and the principal island groups.

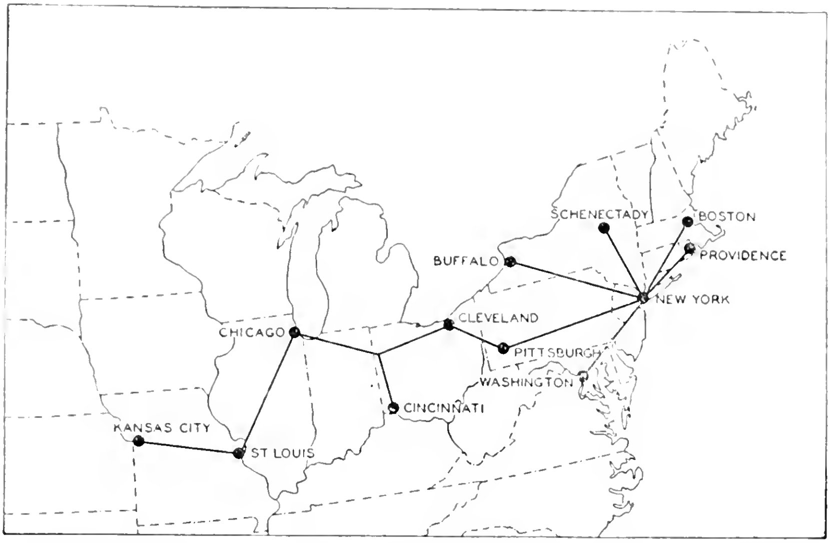
Poulsen, Marconi, Fessenden, DeForest and others had early experimented with the transmission of music by radio telephone, with results that, in those pioneer days, were considered satisfactory. The first of the broadcasting stations which have survived until the present was KDKA, Pittsburgh. This station presented its first regular program on Election Night, November 2, 1920, the broadcast consisting of a running account of returns announcing the election of President Harding.

Other broadcasting stations were opened at various points throughout the country. Originally, their programs consisted entirely of music, talks or other forms of entertainment originating within the studio of the broadcasting station itself Somewhat later, some of the stations began to go to more remote points to "pick-up" programs of one form or another—music by hotel orchestras, church services, football games and other sporting events, political conventions and similar public gatherings. For this purpose, wire circuits were employed from the point of origin to the radio broadcasting stations.

It was at this point that the telephone companies first entered the field of radio broadcasting. It would have been technically possible, of course, for each broadcasting station to install its own circuits from the point where the program originated to its studio, but this would have proved unduly expensive. In many cases, however, local telephone companies already had circuits running to the points of origin, as well as to the broadcasting studios, and the necessary circuits could frequently be provided by connecting two such circuits to form a continuous link between point of origin and radio station.

Meanwhile, it had become apparent to the executives and engineers of the American Telephone and Telegraph Company, the headquarters company of the Bell System, that the development of radio telephony, and its quite obvious usefulness for this new form of communication, imposed upon the Bell System what was nothing less than an obligation to apply to its development the accumulated experience of years of research in the field of wire telephony.

Much that had been learned during the development of a telephone system which by this time was nation-wide in its reach would, obviously, be invaluable in the development of



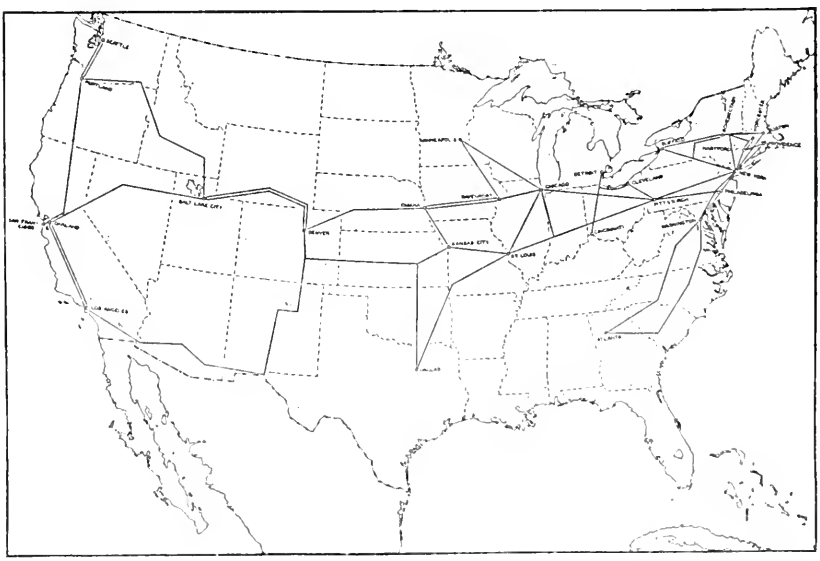
In 1924 It Was Considered a Major Accomplishment when Bell System Wires Connected Radio Stations in Twelve Cities for Broadcasting the Proceedings of the Republican National Convention.

radio telephony, both for point-to-point transmission and for broadcasting. The Bell System's intensive study of the characteristics of sound, and particularly of speech sounds; its research directed toward ascertaining the best methods of transforming these sounds into electrical impulses and transmitting them clearly over greater and greater distances; its development of apparatus for amplifying telephone currents which had lost strength, due to attenuation, while traveling over these long stretches of wire—this and a vast amount of other information had been accumulated during more than half a century of telephone development. In a peculiar and very true sense, the Bell System held this information as trustee, and was under the definite obligation of utilizing it in any field of communication in which it might prove valuable in advancing the interests of the public.

It soon became obvious that radio broadcasting was such a field—that there was a public need for this type of service.

But just how general this need was, or how pronounced or how permanent the demand for broadcasting service was to become, were questions as yet unanswered. If such a demand were to become widespread and if it were to give evidence of permanency, it was apparent that the Bell System would have not only an opportunity but an obligation to contribute what it could, in view of its long experience in the field of wire telephony, to the development of radio broadcasting. It was almost equally apparent that this contribution would lie not only in the direction of assisting in developing transmitting apparatus for the broadcasting stations and designing improved receiving apparatus, but in the equally important field of linking broadcasting stations with the points of origin of their programs and of connecting stations for simultaneous broadcasting—that is, for what later came to be known as chain or network radio service.

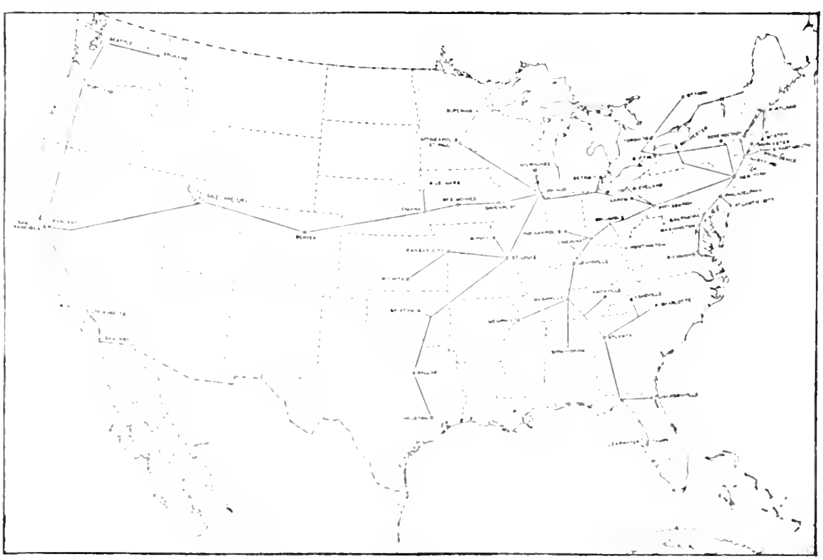
But the participation of the Bell System in any of these



THE SECOND NATIONAL DEFENSE DAY PROGRAM, JULY 4, 1925, FOUND TELEPHONE WIRES UNITING RADIO STATIONS FROM COAST TO COAST.

phases of the development of radio broadcasting could be justified only by a study of the public need, as indicated by public demand, for this type of service. If this demand was to be limited in extent, or to give evidence of a public interest which would have no permanency, the expenditure of effort or capital on radio broadcasting would be obviously unjustified.

In order to continue its research in radio telephone transmission, begun in 1915, the Bell System established, late in 1921, an experimental station known as 2XB. This was located at 463 West Street, New York City, at what is now the Bell Telephone Laboratories. About the middle of 1922, Station WBAY was put into operation at 24 Walker Street, New York City, and shortly thereafter Station 2XB was given the call letters WEAF. Stations WBAY and WEAF were operated for some time, until WBAY was abandoned and WEAF became the Bell System's only broadcasting station in New York. These Bell System stations were used, not alone for the pur-



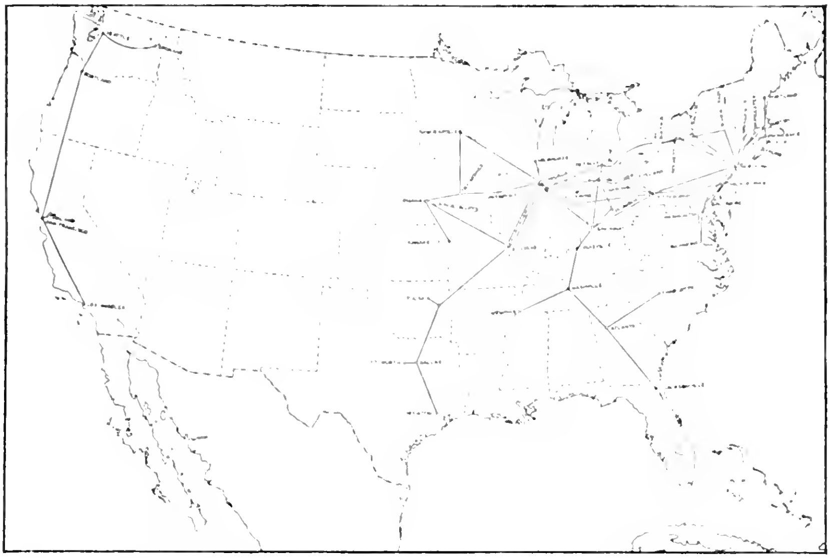
By the Time of the First Tunney-Dempsey Bout in 1927, Radio's Reach Had Been Extended to the Limits of the Country, North, South, East and West.

pose of continuing experimentation in radio telephone transmission, but for the not less important purpose of ascertaining the public reaction to radio broadcast programs of high quality. These stations became, in effect, laboratories in which were studied certain technical problems and the problem of public demand for radio broadcasting programs. After this experimental work had been completed, Station WEAF was sold to the Radio Corporation of America, ownership subsequently being transferred to the National Broadcasting Company.

Meanwhile, Bell System engineers and scientists had done a considerable amount of work which was to have a direct bearing upon the development of radio broadcasting, and particularly on the use of telephone circuits for program transmission. Before the actual development of radio broadcasting, much broadcasting had been done with the so-called public address systems, in which loudspeakers were used to cover large audiences. In many instances, the speech and music thus broadcast was transmitted over long distance telephone circuits, a notable example being the transmission of the ceremonies attending the burial of the Unknown Soldier on Armistice Day, 1921, when large audiences in New York and San Francisco, as well as that at Arlington, Va., were enabled to listen to the impressive program.

The apparatus and methods developed for use in connection with the public address systems were applied to the new field of radio broadcasting and proved to be invaluable contributions, since it also demanded high quality reproduction of speech and music.

An early instance of the combination of the public address system, long distance telephone lines and radio broadcasting was afforded by the reporting of a football game played in Chicago in the fall of 1922. By means of high quality transmitters and amplifiers located at the football field, announcements of the plays and the applause of the spectators were delivered to a cable circuit extending to the toll office of the



THESE WERE THE CHAIN BROADCASTING CIRCUITS REGULARLY FURNISHED BY THE BELL SYSTEM AT THE END OF 1927.

telephone company in Chicago. This circuit was connected there to a toll line to New York, where it delivered the telephonic currents to a radio broadcasting transmitter. In Park Row, New York, a truck was provided with a radio receiving set which was arranged to operate a public address system. In this experiment the factors involved were essentially those which characterize modern chain or network broadcasting: a source of the program; suitable apparatus for picking it up; a telephone circuit connecting this source with the radio broadcasting station; the transmitter at the latter station; and, finally, the listener's receiving set.

Early in the following year, station WEAF was to participate in experiments which more closely suggested the linking of two or more broadcasting stations for the transmission of the same program.

The first of these experiments took place in January, 1923, when a special telephone talking circuit joined Station WEAF with Station WNAC, Boston. As radio receiving sets of that day were, for the most part, home-made devices with ear phones, and listeners were not critical of the quality of reception, the radio public as a whole was well satisfied with the success of the experiment.

Not so the Bell System engineers who had conducted it. They knew that transmission over the wires linking the two radio stations could be bettered—and that it would have to be bettered if the future of network broadcasting was to be assured. They knew that there is a vast difference between the transmission of speech, as in the case of regular telephone service, and the transmission of music over the same wires. They knew that, for the latter purpose, specially designed circuits would have to be used. They designed such circuits and, in an experimental test in which Station WEAF was linked with Station WMAF, South Dartmouth, Mass., in the summer of 1923, they put such a specially designed circuit into operation. The special apparatus required for the test was removed after the completion of the experiment, but with this "hook-up" the history of modern chain or network broadcasting began.

For it has been—in America, at least—the linking of broadcasting stations by a far-reaching web of telephone wires that has made radio broadcasting what it is today. Not otherwise could the hundreds of broadcasting stations which serve the nation—many of them in small cities, remote from the larger centers of population—have tapped the supply of artistic talent of which they are now giving their listeners the benefit. In no other way could football games and other sporting events, the proceedings of political conventions and other public gatherings, or the voice of a President, speaking from his study in the White House, be brought to the millions of American radio sets. Technical and economic limitations alike would have prevented the evolution of radio broadcasting into anything like the high degree of development it has reached in the United States, were it not for thousands of miles of telephone wire. Stretching from coast to coast and from Canada to Mexico, these telephone circuits have been utilized in binding radio stations together into groups and, as occasion demands, uniting these groups into a single network that is nation-wide in its extent.

At important centers throughout the country, as at New York, Chicago, and San Francisco, so-called "control points" have been established and constitute the nerve centers of the 88,000 miles of wire regularly used by the eleven basic networks. Scores of other telephone buildings house the complex apparatus required for this form of service. These thousands of miles of wire are carefully watched over by specially trained employees totalling between 400 and 500 men.

The part which the telephone plays in making possible the far-reaching radio broadcasting networks which serve America's millions of listeners has been summarized by an officer of one of the large broadcasting companies as follows: [1]

> It is to the telephone, not to radio, that we owe the development of the equipment whereby speech and music are made available for broadcasting.
>
> More than this, it is the telephone wire, not radio, which carries programs the length and breadth of the country. John Smith, in San Francisco, listens of a Sunday afternoon to the New York Philharmonic Orchestra playing in Carnegie Hall. For 3200 miles the telephone wire carries the program so faithfully that scarcely an overtone is lost; for perhaps fifteen miles it travels by radio to enter John Smith's house. And then he wonders at the marvels of radio!
>
> But what about programs from overseas? Here, indeed, wireless telephony steps in, but not broadcasting in the ordinary sense. The program from London is telephoned across the Atlantic by radio, but on frequencies entirely outside of the broadcast band.
>
> Broadcasting, then, is the child of the telephone; in America it is certainly the child of the American Telephone and Telegraph Company. The whole structure of commercial chain broadcasting as we know it today has grown out of the pioneer work done prior to 1926. Telephony has largely created the mechanism of broadcasting.

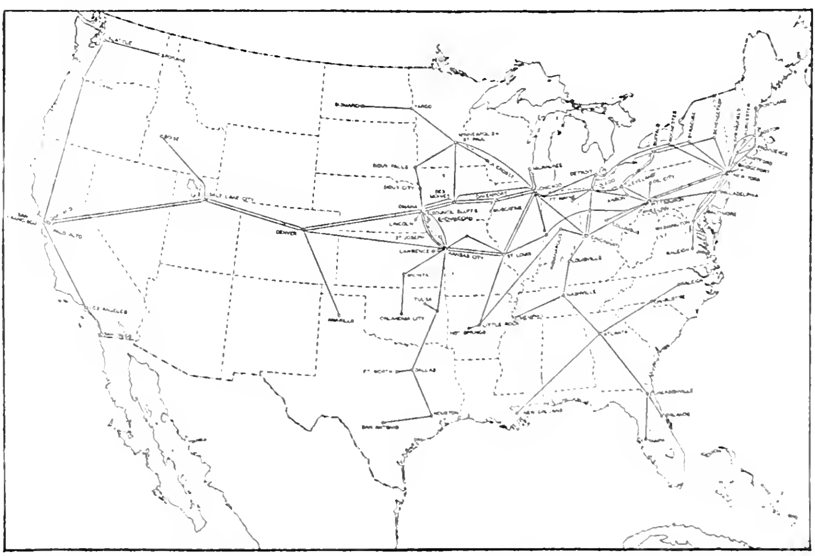
It is quite possible that the hypothetical John Smith, to whom this writer refers, may be aware that the program to which he

[1] "Broadcasting: a New Industry," *Harvard Alumni Bulletin*, December 18, 1930.

is listening in San Francisco has not been carried across the continent by radio. But it is also quite possible that his information on the point does not extend far beyond the vague notion that in some way that he does not understand, "it is done by telephone wires." And to John Smith, and millions like him, a telephone wire is a telephone wire, and that is the end of the matter.

But it is not the end of the matter for the engineers of the American Telephone and Telegraph Company. They have learned from long experience that the technical problems involved in the provision of circuits for the broadcasting networks are quite different from those confronted in the provision of commercial telephone service, with which the Bell System organization has long been thoroughly familiar and for which its plant and equipment have been designed.

From the days when Alexander Graham Bell conducted the first of the experiments which led to his invention of the tele-



On the Night Before the 1928 Presidental Election, Bell System Chain Broadcasting Circuits Served a Countrywide Line-up of Stations.

phone, he and his successors of the organization which bears his name have been students of sound and of its electrical transmission. When confronted with the problem of providing circuits for network radio broadcasting, they knew, from more than half a century of experience, that this problem involved factors not encountered in the provision of regular, commercial telephone service.

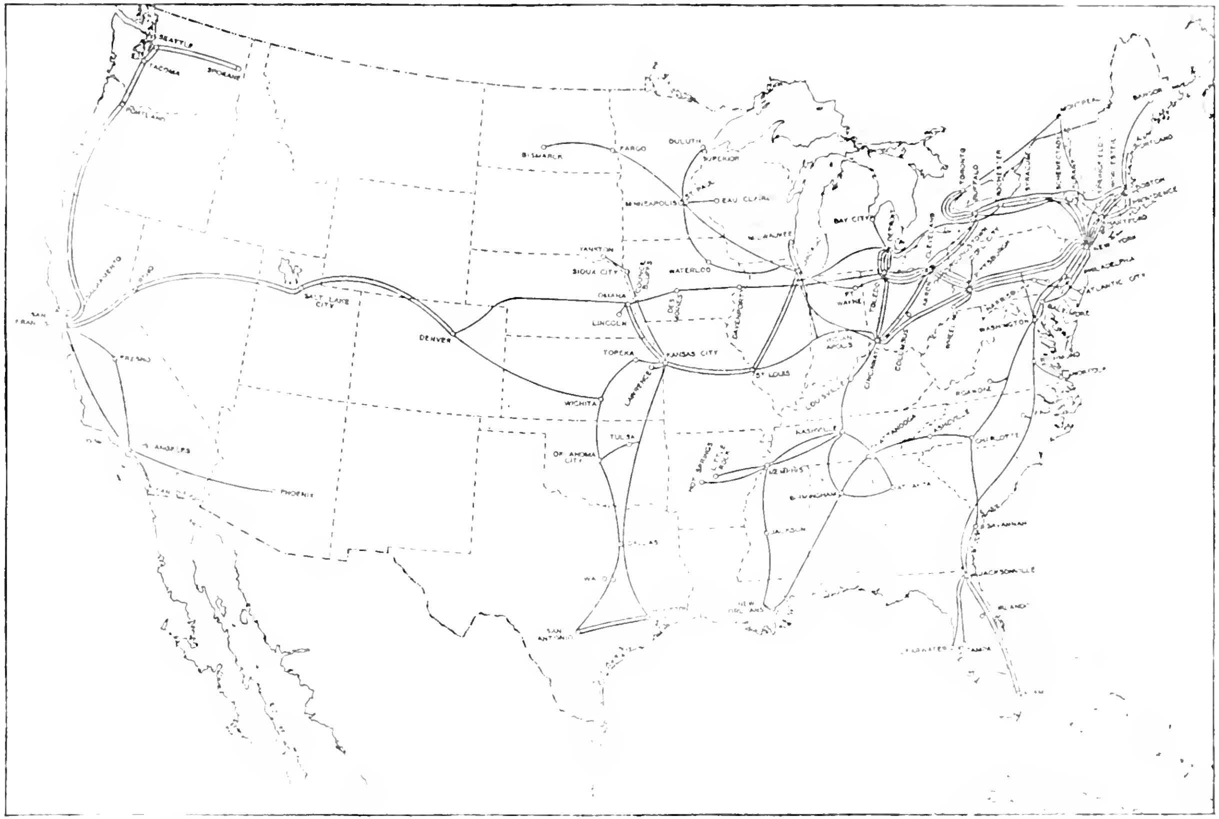
Telephone wires had, it is true, been used as early as 1877, the year following the invention of the telephone, for the transmission of music. In order to arouse public interest in the telephone, Bell gave demonstrations or lectures in various cities of the East, and one of the features of these was the transmission of songs, cornet solos, cabinet organ and similar musical selections from some outside point to the auditorium in which the lecture was held. In the light of present knowledge of the telephone art, however, it is perhaps safe to assume that these demonstrations, though they amazed the audiences which heard them, were reminiscent of Dr. Samuel Johnson's comment on the performance of a dog which he had seen dancing on its hind legs. The good doctor remarked, it will be remembered, that the spectacle was extraordinary—"not because the dog danced particularly well, but because it danced at all."

Imaginative writers—and artists, for that matter—of the early days of the telephone, delighted in predicting the time when entire audiences, as well as individual telephone subscribers, would be entertained by opera and orchestra programs transmitted over the wires. The truth is that music carried by wire, in the pioneer days of telephony, was hardly more than sufficiently faithful in its reproduction to be recognizable as music. As an entertainment feature, its attraction lay in novelty rather than in esthetic beauty.

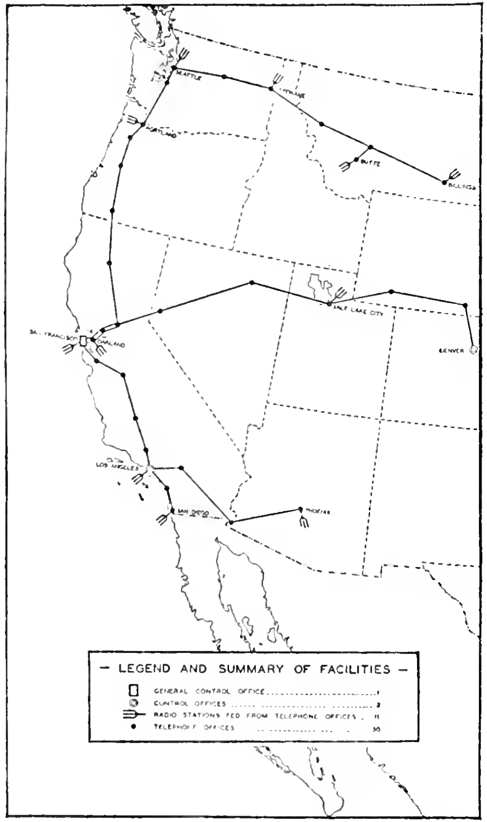
Since these early days, telephone instruments and circuits have been much improved. The telephone today is quite adequate for transmitting speech which can be clearly and easily understood. Even today, however, regular telephone circuits are not adequate for transmitting musical selections or other entertainment programs. There are sound technical reasons for this. For every-day telephony, the prime requirement is ability to transmit messages easily and accurately and at reasonable cost. The transmission of music and other sounds for entertainment purposes, however, involves much more severe technical requirements than the satisfactory transmission of speech for message telephone service, in order to maintain, for example, the aesthetic values involved in the reproduction of high grade music. In order to meet the qualities demanded for program transmission, it has been necessary for Bell System engineers to develop and provide special circuits quite different in their characteristics from ordinary telephone circuits. Their inherently higher cost is justifiable because of the fact that, in broadcasting, a single circuit is shared by many listeners.

Take the matter of frequency range, for example. For every-day telephony, circuits which will transmit a frequency range of somewhat more than three octaves, starting with middle C, give a high degree of intelligibility so that ideas can be easily and accurately interchanged. Circuits for entertainment purposes, however, require that a range of frequencies more than twice as wide as this be transmitted. The higher frequencies transmitted over these circuits add to the "brilliancy" of music, since more of the high-pitched notes and important overtones are transmitted. The lower frequencies give "body" to the reproduction. Transmitting these higher and lower frequencies, in other words, reproduces the programs much more naturally, so that nice distinctions between sounds of various musical instruments are preserved.

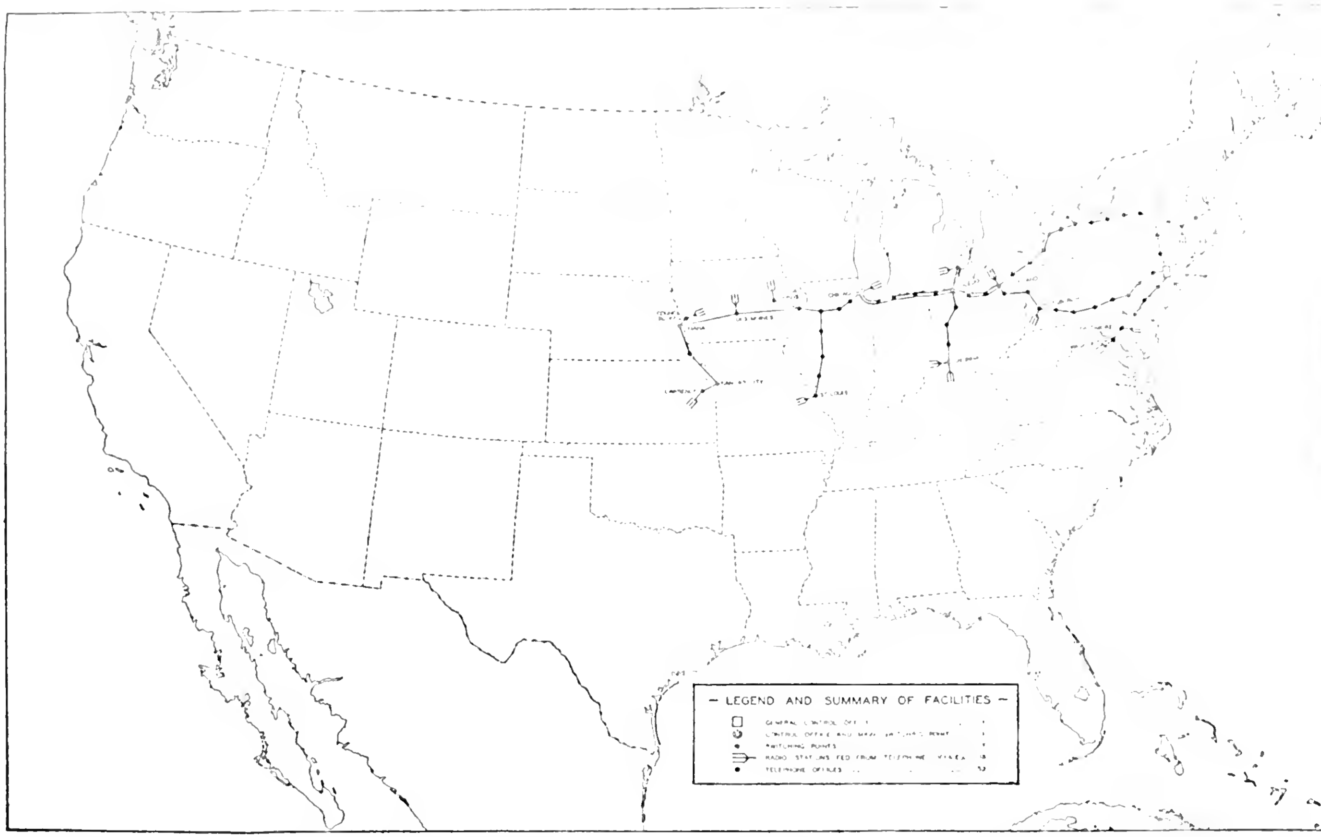
Circuits used for radio program transmission must also be so designed as to take care of a considerable variation in volume or loudness. In an ordinary telephone conversation, the range of variation in volume is relatively small. When, however, a musical selection, as, for example, a concert by a symphony



Program Transmission Networks Provided by the Bell System as of March 15, 1931.



Radio Broadcasting Stations Connected by Bell System Circuits for the National Broadcasting Co. (Red Network, Right; Orange Network, Left) Early in 1934.

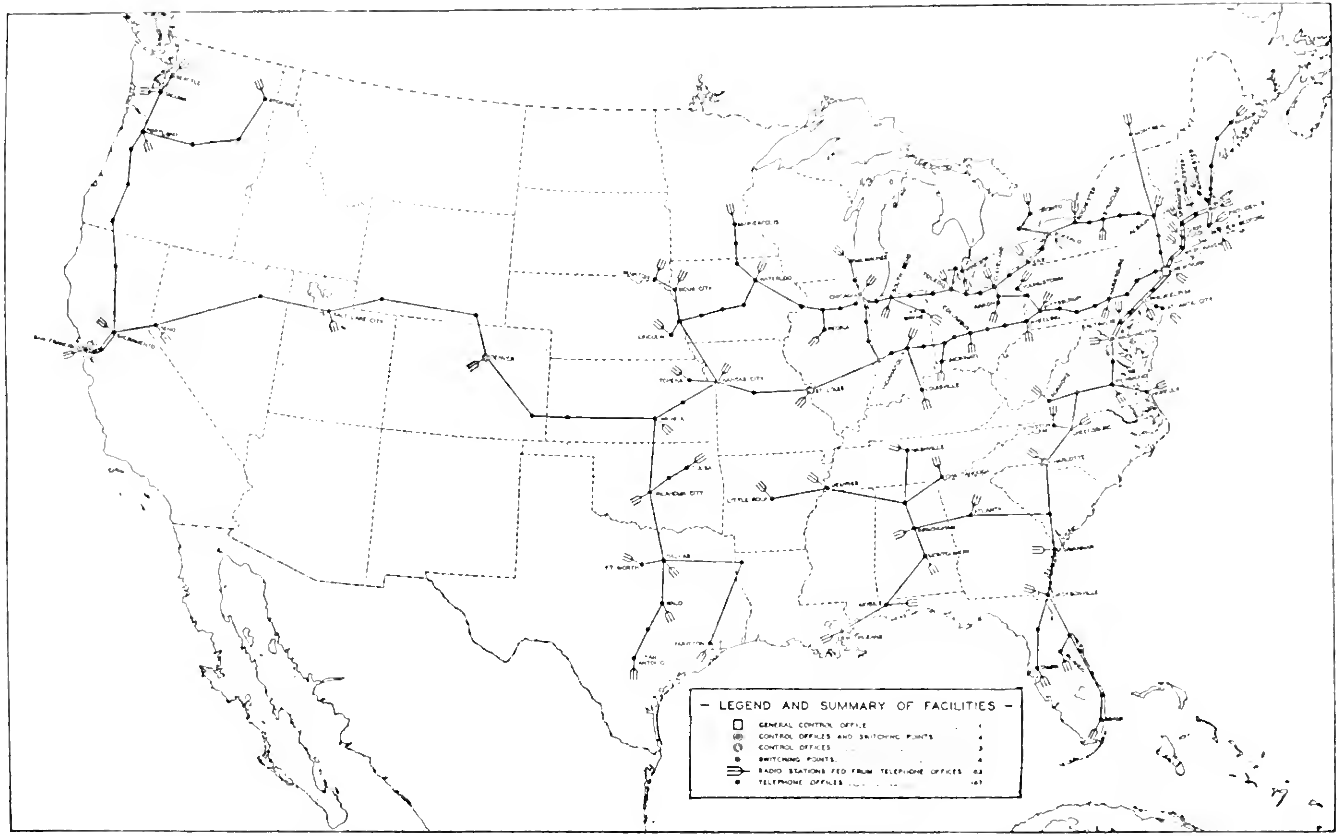


Radio Broadcasting Stations Connected by Bell System Circuits for the National Broadcasting Co. (Blue Network) Early in 1934.

orchestra, is to be transmitted, the circuit must be arranged so that the weaker passages will reach the radio listener clearly and without "cross-talk" or other undesirable noise. The circuit must also be specially arranged so that when the higher volumes are transmitted, the apparatus in the circuit will not overload and thus distort the musical tones. For these higher volumes it is also necessary to take special care to avoid the possibility of "crosstalk" from the program circuit into paralleling circuits which may be carrying other programs or regular telephone messages.

Provision must also be made for still another factor which, although also encountered in the transmission of speech, is of particular importance in the transmission of music, by reason of the wide range of frequencies transmitted in the latter case. This is technically known as delay distortion. Although the electrical currents on a telephone line travel very rapidly—from 10,000 to about 180,000 miles per second, depending on the type of circuit—there is, on a long circuit, a measurable period of time—though often only a small fraction of a second—during which the electrical impulses are traveling from the transmitting end to the receiving end of the circuit. The different tones or frequencies may travel at varying speeds and arrive at the receiving end of a long circuit at different times, thus overlapping each other and causing a blurring or distortion. Special means of avoiding or correcting this distortion must be employed when long circuits are to be used for high quality program transmission.

The provision of the high grade program transmission circuits now in service has been a gradual development. In the early days of network broadcasting, open-wire circuits were largely used, as they could more readily be made suitable than the cable circuits then available. Later, it became the practice of the Bell System, when installing cable required for its regular long distance telephone business, to include a number of 16

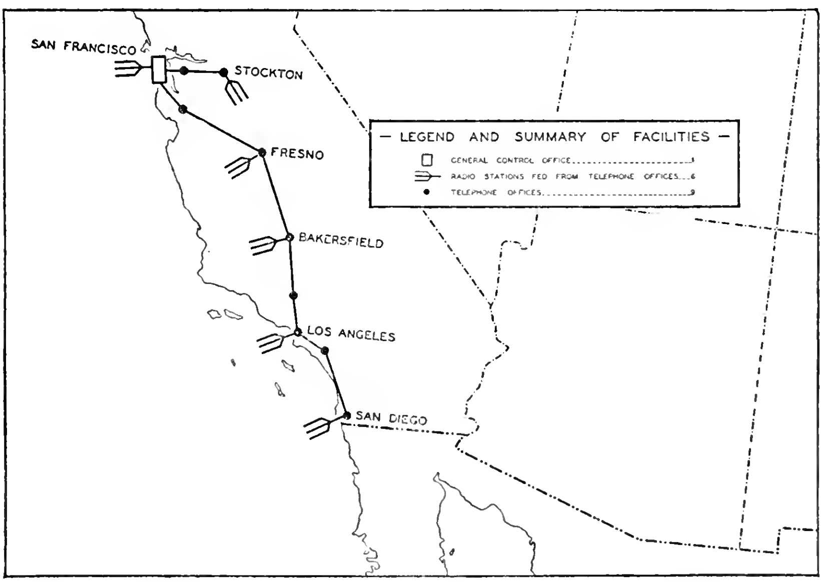


RADIO BROADCASTING STATIONS CONNECTED BY BELL SYSTEM CIRCUITS FOR THE COLUMBIA BROADCASTING SYSTEM (PURPLE NETWORK) EARLY IN 1934.

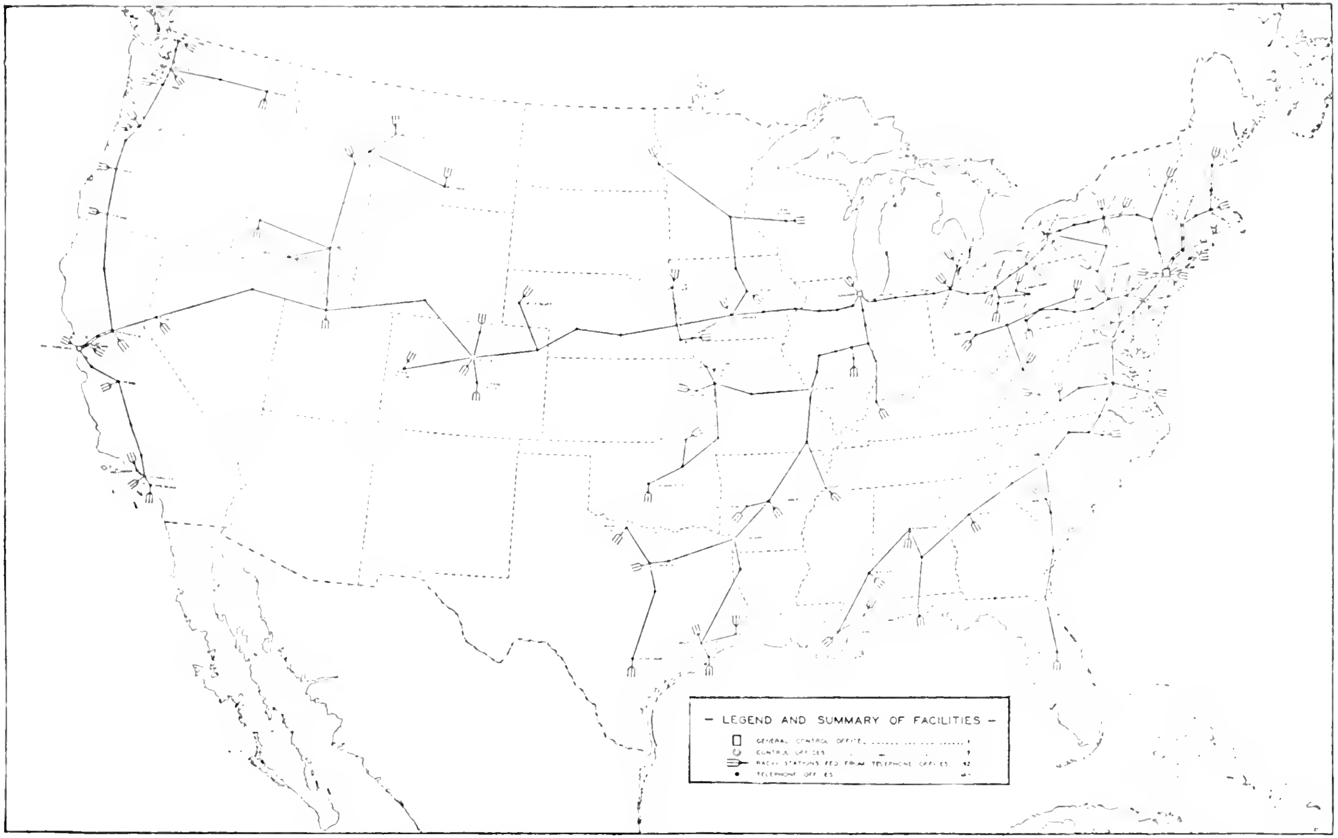
gauge pairs specially located in the cables which were reserved for use in providing radio network facilities.

In addition to providing these special conductors, it is necessary to provide special forms of amplifying equipment or repeaters, capable of taking care of the wide range of frequencies to be transmitted. Various other forms of supplemental apparatus, including special loading coils, are also required.

Whenever a circuit is removed from regular message service and transformed into a program circuit, the change involves the loss, not only of the two physical wires which make up the circuit, but of other circuits which might otherwise be operated simultaneously with the regular telephone circuit on this same pair of wires. Thus, on open wires, a change from message to program service means giving up the use of the same conductors for telegraph messages which would ordinarily be transmitted simultaneously with the telephone messages and often the sur-



BELL SYSTEM HOOK-UP FACILITIES PROVIDED FOR DON LEE IN THE SPRING OF 1934.

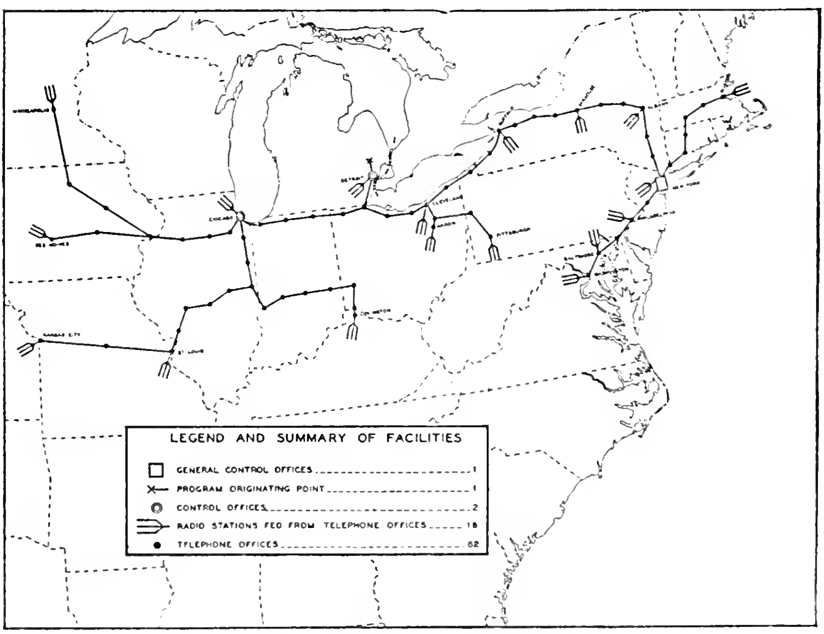


Radio Broadcasting Stations Temporarily Connected by Bell System Circuits for the People's Pulpit Association in October, 1933.

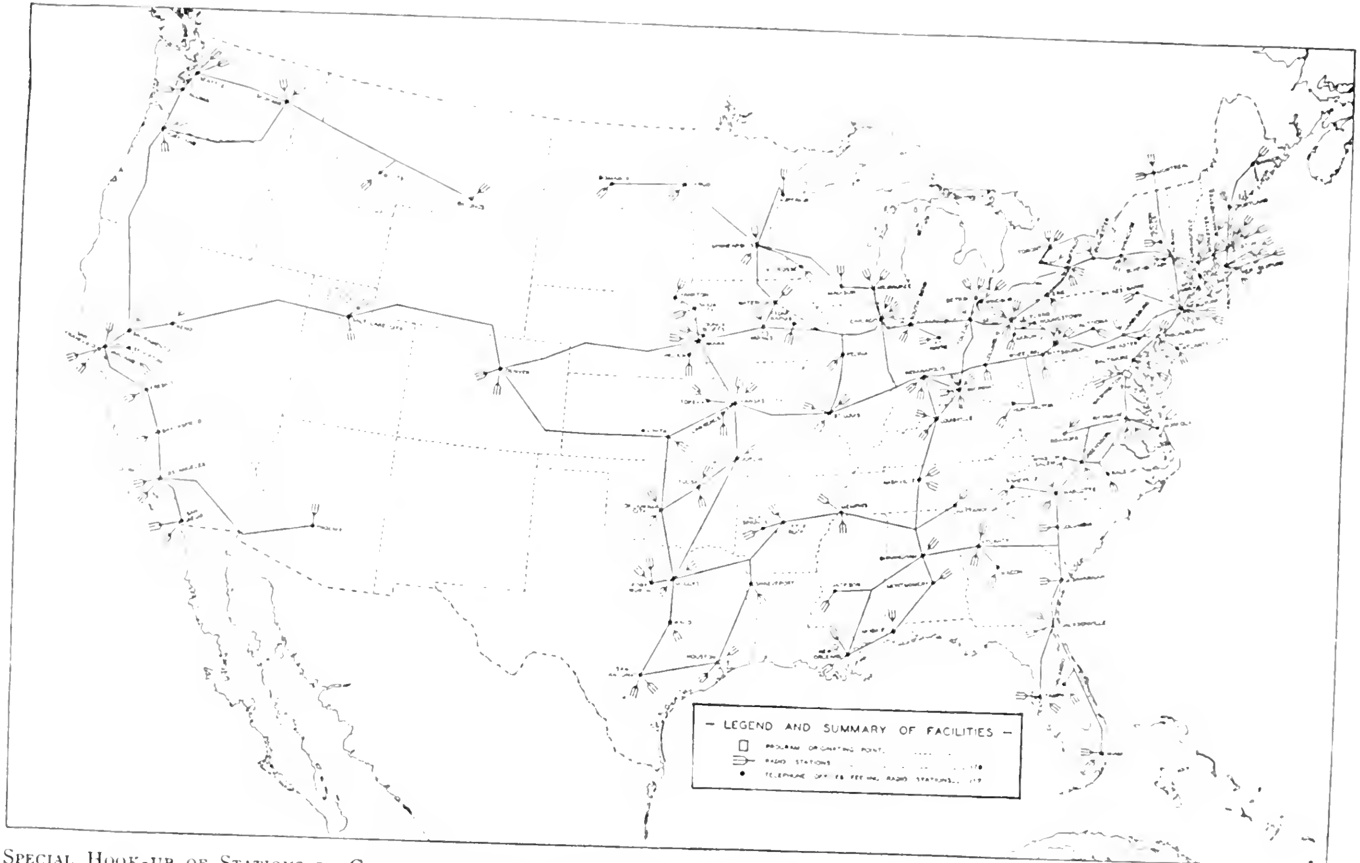
render of two or three message telephone circuits in order to obtain one program circuit. Where cable construction is used, special pairs devoted wholly to program service are generally provided, but where, for shorter distances, pairs normally intended for message service are employed, a similar sacrifice is necessary.

It should be borne in mind that, as the efficiency of radio broadcasting equipment and radio receiving sets has been improved, there has been a growing demand for better quality of transmission over the program circuits provided by the Bell System to the broadcasting companies. Circuits which might have been acceptable a few years ago would now prove quite inadequate to meet the requirements of the broadcasting companies today, or those of their millions of radio listeners.

The provision of physical circuits and the supplementary



Bell System Hook-up Facilities Provided for Station WJR, Detroit. (Yellow Network—Father Coughlin.)



Special Hook-up of Stations in Connection with Countrywide Celebration of President Roosevelt's Birthday, January 30, 1934.

apparatus required to make them adequate to the requirements of radio network transmission has necessitated the investment of large amounts of money on the part of the Bell System. To this must be added still other investment in apparatus required to switch from one station to another as the "layouts" for the various programs change from period to period throughout the day. To this must be added the cost of various forms of control and monitoring apparatus and of circuits set aside for telegraph or teletypewriter communication required in the operation of the networks.

But the provision of this service requires more than the investment of money in machinery—it necessitates the employment of man-power on a nationwide front. At various points along the thousands of miles of wire which constitute the broadcasting network, specially trained telephone employees are stationed, charged with the important responsibility of watching over the circuits, seeing that the quality of transmission is at all times up to the required standard, making the innumerable switches that are required in the routine of changing from program to program—and standing by, ready to change, at a moment's notice, from a regular program circuit to a "spare" or alternative circuit if trouble develops in an emergency.

As has been said, the past development of the program circuit service furnished by the Bell System to the broadcasting companies has been a gradual development, an evolution. As radio transmitting and receiving apparatus has been improved, the circuits linking broadcasting stations have had to be improved correspondingly. The Bell System has endeavored in the case of this service—as it always has in the case of its regular message service—to keep in advance of the requirements of the public it serves. To maintain this advance, it must look into the future; anticipate, in so far as this is possible, the radio broadcasting requirements which this future will bring; and plan to meet these requirements. A part of the service which it is providing to meet the needs of the present consists of preparing for the needs of the future and of making a reasonable investment to this end.

Money, mechanisms, men—these are the elements which lie behind the provision of the telephone circuits required to make possible radio broadcasting as America knows it today. They are the fundamentals upon which has been built, in response to a public need, a far-reaching public service.

R. T. BARRETT

Network Broadcasting

II. Operating the Networks

TO operate the circuits required for program transmission demands the specialized knowledge and experience of hundreds of telephone employees. The individuals making up this group are scattered in every part of the country. Yet so close is the coördination of the group that to all intents and purposes they might be working in the same room.

Perhaps the best method of giving an accurate picture of their activities is to describe the hour-to-hour detail of the operation of a network throughout the period of a typical day. To this end, networks comparable to those in actual operation are discussed in the following paragraphs.

The networks, for simplicity, will be designated A and B. The key station for both networks is New York, but a fairly large number of programs originate in Chicago. The insert facing page 100 gives the layout of each network and shows the six main switching centers where the Telephone Company's forces perform switching for the broadcaster. These networks are in service sixteen continuous hours daily, from 8 A.M. to 12 midnight under normal operation, with such overtime service as may be desired.

New York, designated as the General Control office, is responsible for satisfactory maintenance of service and execution of all orders received from the broadcaster. A general view of a section of this office is shown in Figure 1. The equipment in this office is devoted solely to program transmission service. The photograph shows less than half the equipment in the office. To facilitate efficient handling of emergency matters, and to improve service maintenance, certain duties are delegated to other offices known as Control offices. For the networks under consideration, Washington, Cincinnati, Buffalo, Chicago, Kansas City, Denver and San Francisco are control offices for the sections extending south and west of each, respectively, to the next adjacent control office. New York also functions as the section control office for each network between New York and Chicago, New England, and sections south to Washington. Each control office is connected with all intermediate amplifier offices in its section by telegraph circuits. The general control office keeps in touch with each control or switching office through a teletypewriter circuit and is connected with certain strategically situated offices by a special "express" telegraph circuit for speed in handling emergency cases.

Now let's start our 24-hour day at 1:30 A.M., when all service is "good-night." Preparation for the start of service for another day must be completed prior to 6:45 A.M., at which time the "Morning Exercises" program must be transmitted over network B to nine stations located in New England, New York, Ohio, Pennsylvania, Ontario, and the District of Columbia. Before the daily routine circuit line-up testing can start, usually certain general maintenance work must be done. To-day, for example, amplifier tube tests are to be made at all offices between New York and Chicago from 1:30 to 2:00 A.M., and both networks have been released during that period. Washington will not start lineup tests until 4:00 A.M., as the B network is released between Denmark and Jacksonville to replace temporarily several sections of open wire with insulated wires, as abnormal flood waters are expected in various lowland sections. Line noise measurements are being made between Memphis and Jackson, Miss., to locate noise due to induction. Cincinnati must await lineup of the section until completion of this special work.

When all of such necessary preventive maintenance work has been completed, each control office measures its section to ascertain that the transmission characteristic and volume are satisfactory. Similarly, all the spare program transmission circuits in its section are tested by each control office. This completed, New York transmits power at various frequencies over the entire network. The terminals and specified intermediate offices measure the amount of received power. Any adjustments needed are made under the direction of the proper control office.

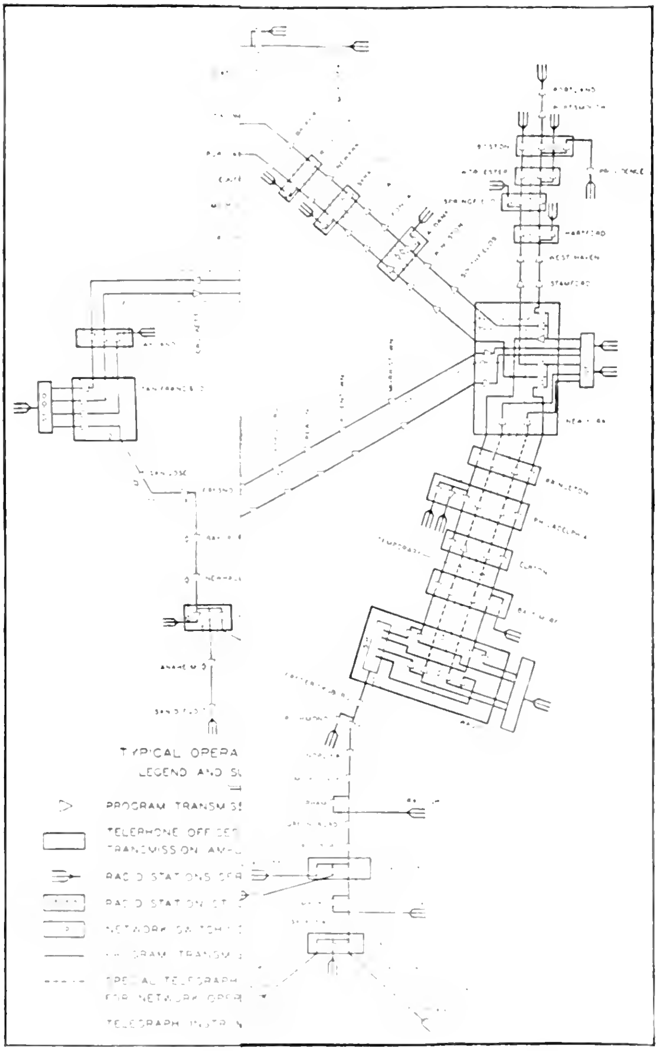
During this midnight-to-morning period, each control office uses the teletypewriter circuit to report the service furnished, troubles experienced, station comments, etc., for the preceding day. The trouble reports are forwarded to the supervisory staff for analysis and record purposes. From the analysis, chronic poor conditions are brought to attention and remedial action initiated.

It is now 6:30 A.M. The New York studios are transmitting test program for the B network. During the next fifteen minutes, by means of the control telegraph wire, New York determines from each office feeding a radio station that satisfactory volume and quality are being received. At 6:45 A.M. the "Morning Exercises" programs begins and it's "all OK" to each of the nine scheduled stations.

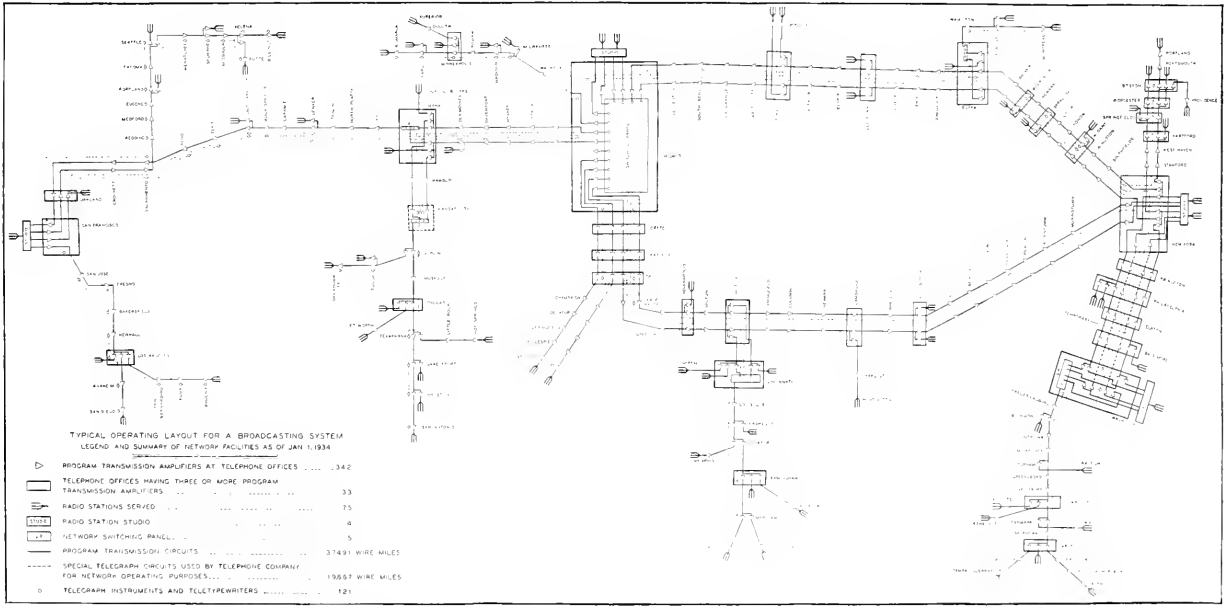
Final arrangements are now made for the start of the day's service at 8 A.M. on the remainder of the B network and the A network. Those sections not receiving the morning overtime service get fifteen minutes test program prior to 8:00 A.M. and each control office determines that "all will be OK" to each radio station in its control section at the start.

Each day the broadcasting company's schedule of operations, showing switching cues and program priority for the following day, is sent to each switching office and from this each office prepares its switching schedule.

At 8:00 A.M. "Morning Meditation" on network A starts the day, while in the same period "Musical Moments" is scheduled for the B network. The northwest, southeast, south central, and southwest sections of the B network start the day



BOSTON
HARTFORD
WEST HAVEN
STAMFORD
TYPICAL OPERA
LEGEND AND SU



Diagrammatic Representation of a Typical Operating Layout for a Nation-wide Broadcasting System.

on network A, but since the switching offices involved have had several hours to set this up, these switches required no special attention.

But what happens at 8:30 A.M.? "Bonnie" is scheduled for the entire B network while the A network gets "Organ Music" program. At the close of the 8:00–8:30 A.M. programs, pre-advised word cues are transmitted over both networks by two broadcast announcers from the New York studios. Switchmen at four Telephone Company offices, Chicago, Washington, Cincinnati and Kansas City, are listening on each network for the switching cues. In this case the cues come simultaneously. The coördination of the two programs by the broadcaster is perfect.

As each switchman hears the cues, he notes the time to the second. He listens to the theme music following the closing announcement. It gradually fades. Twenty seconds after the cue, he performs a switching operation which disconnects the supplementary leg from network A, and properly terminates the input of the amplifier on the supplementary leg as otherwise each radio station on that leg might experience "open circuit" noises for a brief interval. Two seconds elapse, a second switching operation is performed, this one connecting the supplementary leg to the B network. All is ready for the next program to start. Each switchman stands by now awaiting the opening announcement of the new program to double check that the switch has been properly executed.

All switches are not so easy. The broadcaster cannot always perfectly synchronize the conclusion of two programs. In order to take care of those instances where one program overruns or concludes ahead of schedule, the switchman uses his program priority schedule. The sequence of operation the switchman will follow is then determined by the switchman, after hearing the first of the unsynchronized cues.

At 9:00 A.M. the supplementary legs are switched to network A at the four offices previously mentioned and also at Omaha

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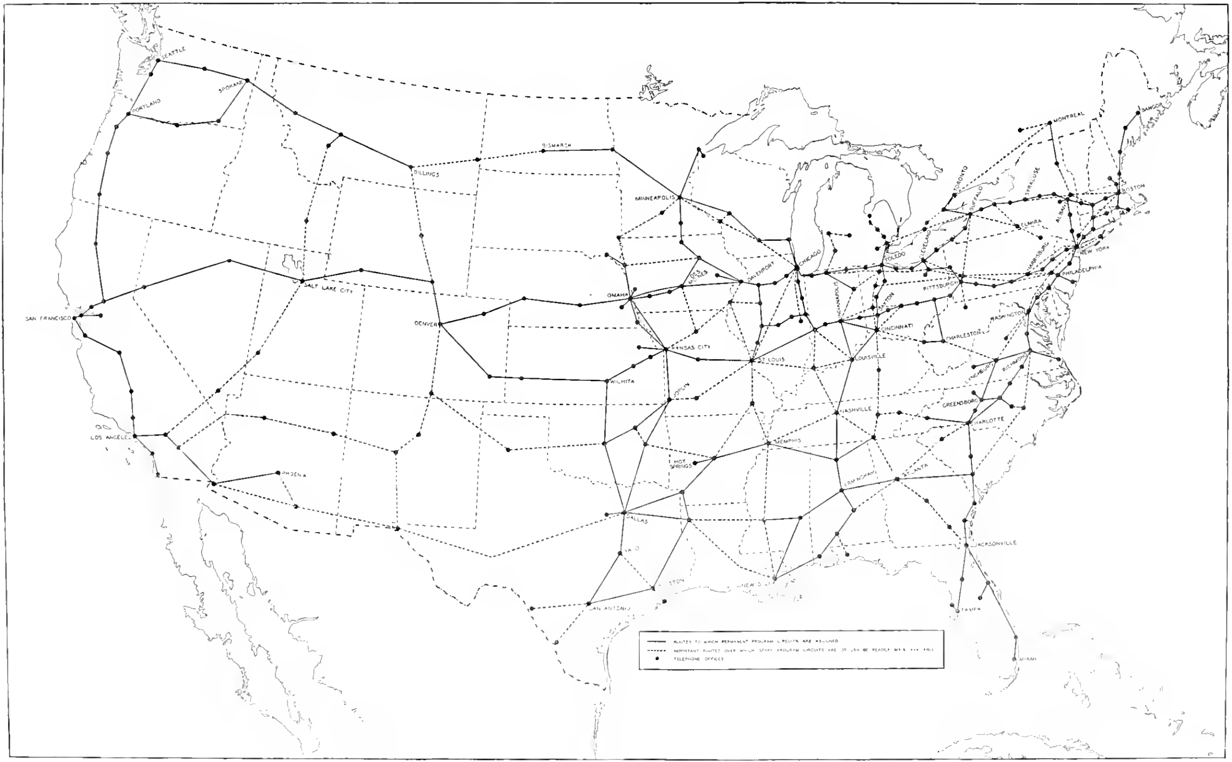
At 9:00 A.M. the supplementary legs are switched to network A at the four offices previously mentioned and also at Omaha and Buffalo for the "Breakfast Club" program from Chicago for the full hour 9 to 10 A.M. Four fifteen-minute programs are scheduled for the B network during this hour.

The "Housewife" program to the B network at 9:15 A.M. originates at Springfield, Mass., and a special circuit transmitting Springfield to Albany is to be used during this fifteen-minute period. For the past hour, Albany has been preparing for this service, by making a program transmission lineup of the circuit. New York General Control checks Albany as to whether everything is "all set" for the Springfield pick-up and receives an "all OK" report. When the closing cue is transmitted over the B network at 9:15, Albany switches the network to feed from the Springfield circuit.

And so it goes each fifteen minutes or half-hour or hour, switching from one network to the other. So far the morning has been uneventful, but at 10:13 A.M. Cleveland flashes New York "Network A just failed." One man at New York, aided by a telegraph wire, starts to locate the trouble while another quickly substitutes a spare program circuit. Service is restored to all points west of Cleveland at 10:15.29 A.M.

Another telegraph flash from Cleveland, "The B network failed at 10:17.30 A.M." The No. 2 spare to Cleveland is connected at New York to the B network transmitting loop and Cleveland is instructed to feed the network west from this spare. All service is restored at 10:18.30 A.M. Buffalo reports the trouble appears to be a cable failure about 30 miles west of Buffalo. Full information is given to the broadcaster with assurance that the Rochester pick-up scheduled for later in the day can be handled.

Chicago, at 11:15 A.M., is advised by Denver that freezing weather prevails on the Central Transcontinental Route around Truckee Pass, Nev.; rain is turning to sleet, ice is forming on the wires, and the wind velocity is increasing. This word is passed to New York and notices are sent to offices along northern and southern transcontinental routes, which routes will not



Map Showing Some of the Routes Used for Program Transmission in 1934.

be affected by the severe weather, to be ready to lineup program circuits for emergency use on short notice. San Francisco advises that it will be prepared to meet either northern or southern routes with facilities into San Francisco.

At 11:18 A.M. the broadcaster's control room says a flash political news story has just broken and service is desired from the Washington studios at 11:30 A.M. It is to be put on the A network from the broadcaster's New York control room and a temporary circuit is needed from Washington to New York. Further, all supplementary legs are now on the B network and were scheduled to remain 11:30–11:45 A.M. This is changed; the supplementary legs must now be fed from the A network. A general call is placed on the teletype circuit for all switching offices. Instructions are formulated and typed simultaneously. A circuit is assigned for use between New York and Washington. The last office signs "OK" at 11:28 A.M. The program starts from Washington at 11:30 A.M. and all radio stations receive it satisfactorily, but by a slim margin and at least ten men in seven widely separated cities have worked with speed and perfect coördination. Figure 3 shows a photograph of one of the general control men taking part in such an operation.

A telegram from Buffalo: "The cable trouble was due to a bullet through the sheath. Expect all pairs OK at 6 P.M." Immediately New York prepares for the Rochester Philharmonic Orchestra program at 3:00 P.M., notifying all concerned: "Use the Rochester-New York section of spare program circuit No. 4 Chicago-New York. At Rochester feed the regular network to Buffalo and the No. 4 spare to New York. At New York feed the regular network from the spare and also the reroute to Cleveland." That's settled.

The next problem is the reversal of the B network, which is normally set up transmitting East–West from Davenport to San Francisco. At 2:00 P.M., for the Woodrow Orchestra, the broadcaster desires West–East transmission. This service is

be affected by the severe weather, to be ready to lineup program circuits for emergency use on short notice. San Francisco advises that it will be prepared to meet either northern or southern routes with facilities into San Francisco.

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The next problem is the reversal of the B network, which is normally set up transmitting East–West from Davenport to San Francisco. At 2:00 P.M., for the Woodrow Orchestra, the broadcaster desires West–East transmission. This service is provided with no change in line and equipment facilities. Equipment and wiring of each intermediate amplifier, Davenport–San Francisco, has been provided so that the connection to the input and output of the amplifier can be quickly reversed between line East and line West by a simple key operation.

A few minutes before the designated time for the reversal, men at each of the thirteen offices monitor the network, awaiting the usual cue. It comes through, reversing keys are operated and dials readjusted to predetermined settings. After this the men stand by several minutes longer to insure that the reversal has been satisfactorily accomplished.

Now a flash from Denver. A pair on the Central Transcontinental line—not the program pair—failed at 2:45 P.M., probably due to sleet. Chicago immediately starts lining up a West Coast program circuit on the Northern Transcontinental route, to be substituted for the program circuits on the Central Line in case the latter go out.

In New York the broadcaster has given corrections to the operation sheet affecting a dozen or so switches in the early evening. These are transmitted to the switching offices involved. New York is also checking various offices for receipt of orders covering a special program from Cincinnati, which will take place 11:30 P.M. to 12 M., requiring a circuit Cincinnati to Dayton, connecting at Dayton to the B network.

Chicago reports OK to San Francisco on the Northern Transcontinental reroute at 4:15 P.M., but as program is still coming through to San Francisco on the central transcontinental route, the northern route has not yet been used.

At 4:30 P.M. the program from the East fails for ten seconds, but an immediate switch at San Francisco to the emergency circuit sustains service with only a few seconds' interruption. Undoubtedly, the bad weather is the cause.

Chicago is advised. Anticipating such a situation, Chicago has prepared a switching schedule for the emergency circuit in accord with the broadcaster's operation sheet, and Pacific Coast

Figure 1. View of a Section of the Telephone Company's General Control Office in New York. The Equipment Shown in the Picture is Used Solely for Broadcasting Network Service.

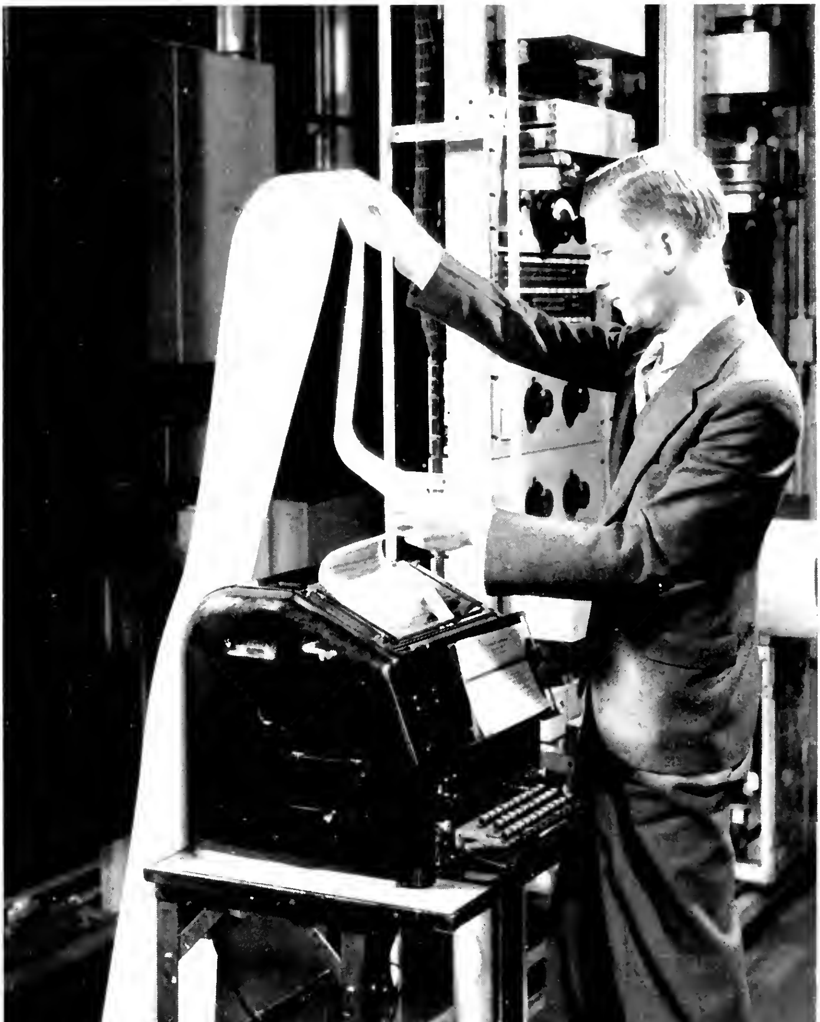


Figure 2. One Day's Program Order, 15 Feet Long, Sent by Teletypewriter from New York to All Telephone Company Offices Involved in Furnishing Network Service.

stations will get each program the rest of the day just as if nothing had happened. Omaha must continue switching, too, because the Denver and Salt Lake City stations will still be fed from the regular network.

And so it goes through the remainder of the afternoon and early evening. The General Control Office checks volume readings half-hourly with each control office. Each switching office carries on its switching schedule in accordance with previous instructions. Each office answers calls from the radio station it serves, giving details regarding trouble and coöperating in any way possible. An hour after midnight the day's operation ends and work starts immediately in preparation for the next day with its special problems.

During certain seasons of the year there are days with many times the activity just described. Football games, baseball games, world conferences, political campaigns, storms covering large areas with extensive damage, fill some of them. Other days are occupied by the preparation and operation of large independent temporary networks, which are established at irregular intervals for a one time service of a half hour to an hour's duration.

E. V. Wallace

Network Broadcasting

III. Telephone Facilities

WHILE the telephone message business is the principal operating undertaking of the American Telephone and Telegraph Company, the furnishing of facilities for program transmission service forms an important part of its activities. To meet the requirements of this service a portion of the physical plant has been designed and especially constructed, or existing plant suitably modified, exclusively for use in program transmission. This plant is set aside for network service twenty-four hours a day every day in the week. It is made up of three main types: equipment, aerial wire and cable plant.

The equipment associated with program transmission service consists of repeaters, power plant, testing apparatus and a proportionate share of the land and buildings required to house the equipment. More than half of the investment in equipment and associated plant is accounted for by the 2,000 telephone repeaters employed in program transmission service. These repeaters have been designed especially to meet the requirements of program transmission service. They are more costly and differ from the repeaters used in telephone message service in several important respects. For example, they will transmit a wider band of frequencies and a wider range of volume. They introduce less distortion through the use of special transformers and contain more refined adjustment features provided by special equalizing equipment which are necessary where programs are to be transmitted over very long distances.

Other special apparatus needed in furnishing this service includes equipment to interconnect sections of the network. For example, at 65 telephone offices throughout the country

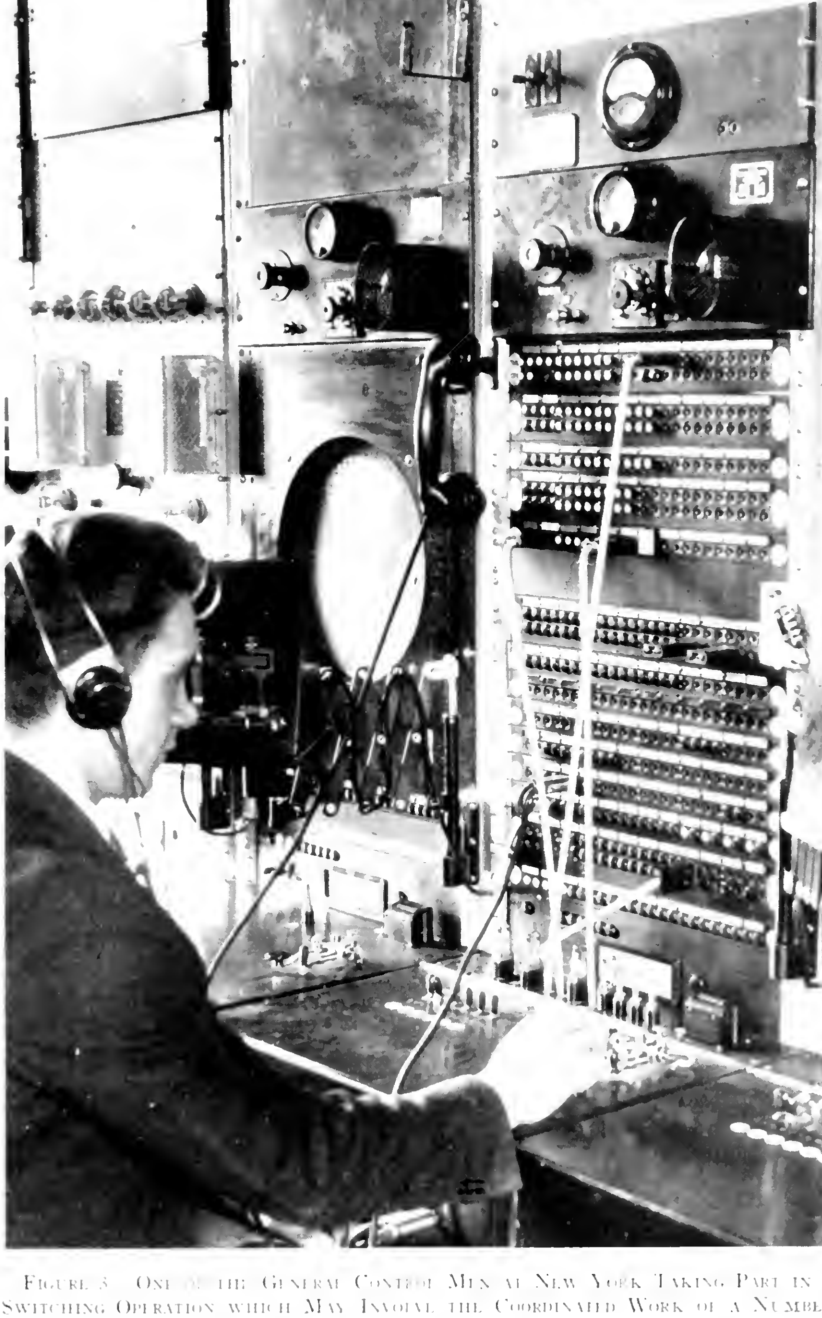


FIGURE 3 ONE OF THE GENERAL CONTROL MEN AT NEW YORK TAKING PART IN A SWITCHING OPERATION WHICH MAY INVOLVE THE COORDINATED WORK OF A NUMBER OF OTHER EXPERTS AT WIDELY SCATTERED POINTS

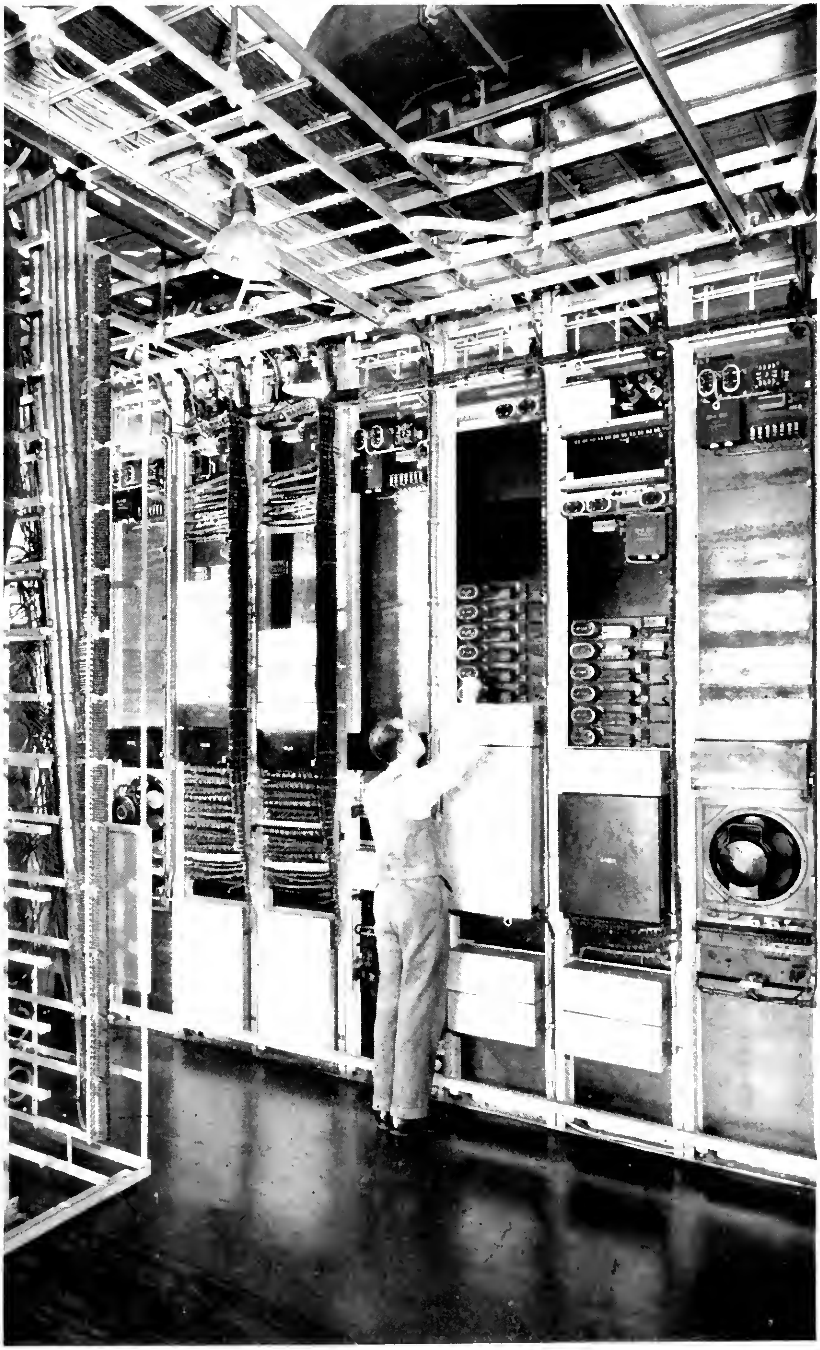


Figure 4. View of Equipment Behind One of the Control Panels in the General Control Office at New York. Note Interconnection Frame at Left

such equipment is installed to enable any program passing through that point to be distributed in various directions over separate routes to supply radio stations on such routes. At 262 telephone offices special positions of testboard equipped for testing, adjusting, monitoring and rearranging the broadcasting networks are installed. The number of such positions varies from one panel in the smallest office to about 25 at the larger centers. Switching positions have been installed at certain points to make practically instantaneous rearrangements in the networks at frequent intervals on a pre-selected basis. Figure 5 shows a typical installation of such equipment at a telephone office.

In recent years there has been an increasing trend on the part of the broadcasters toward supplying certain sections of the country with selected types of programs. There is also a growing tendency toward picking up programs from one studio after another at widely distant points. Such procedures involve special arrangements to make possible the reversal of operation of the networks, on the one hand, and, on the other hand, the quick shifting of groups of stations from one network or a section of a network to another at frequent intervals. These new developments in network service require an increasing use of the switching arrangements mentioned above.

The aerial wire plant used for network broadcasting totals about 53,000 miles of wire. It is assigned about as follows: 34,000 miles for full time service; 6,000 miles for recurring service; 8,000 miles for protection and special occasions; 5,000 spare but available for use. If aerial wire were used for regular telephone message purposes a number of additional telephone and telegraph circuits would be secured through the use of so-called carrier systems, phantom circuits, and composite telegraph operation. Due to the exacting requirements of the program service, no composite telegraph operation is practicable and less than ten per cent of the potential phantom telephone circuits can be utilized.

Cable plant devoted to network service provides approximately 59,000 miles of wire equipped for use and about 68,000 miles provided for future use, not fully equipped for service as yet. The wire equipped for use is assigned as follows: 23,600 miles for full time service; 10,000 miles for recurring service; 12,000 miles for protection and special occasions; 13,400 miles spare but available for use.

Practically 90 per cent of the cable wire mileage is made up of 16 gauge cable pairs specially provided for program transmission. Since 1926, these special conductors, usually six pairs in each case, have been placed in nearly all long distance cables. The number of pairs has been determined on the basis of the estimated requirements for broadcasting circuits over a reasonable growth period. It is necessary to place all of them in the cable at the time of installation, as, otherwise, facilities for program transmission would not be available when required. In most cases, three pairs are arranged particularly for transmission in one direction and three for transmission in the opposite direction. These pairs are not arranged for phantom use, as are the other cable circuits, and they are so located in the core of the cable that interference between circuits is reduced to a minimum. The circuits are loaded with special loading coils designed for broadcasting purposes. These coils are placed at 3,000 foot intervals, whereas the usual type of loading coils used on the same cables are placed at intervals of 6,000 feet. While the manufacturing cost of the individual loading coil designed for broadcasting purposes is not greatly different from the cost of coils used for message circuits, the installed cost of the system is considerably greater. Twice the number of coils is used and they are installed in small special cases each containing six coils for equipping the six specially provided cable pairs.

The use of these circuits for message purposes, while physically possible, would not be economical, as the conductors are of larger gauge than would be provided for message circuits,

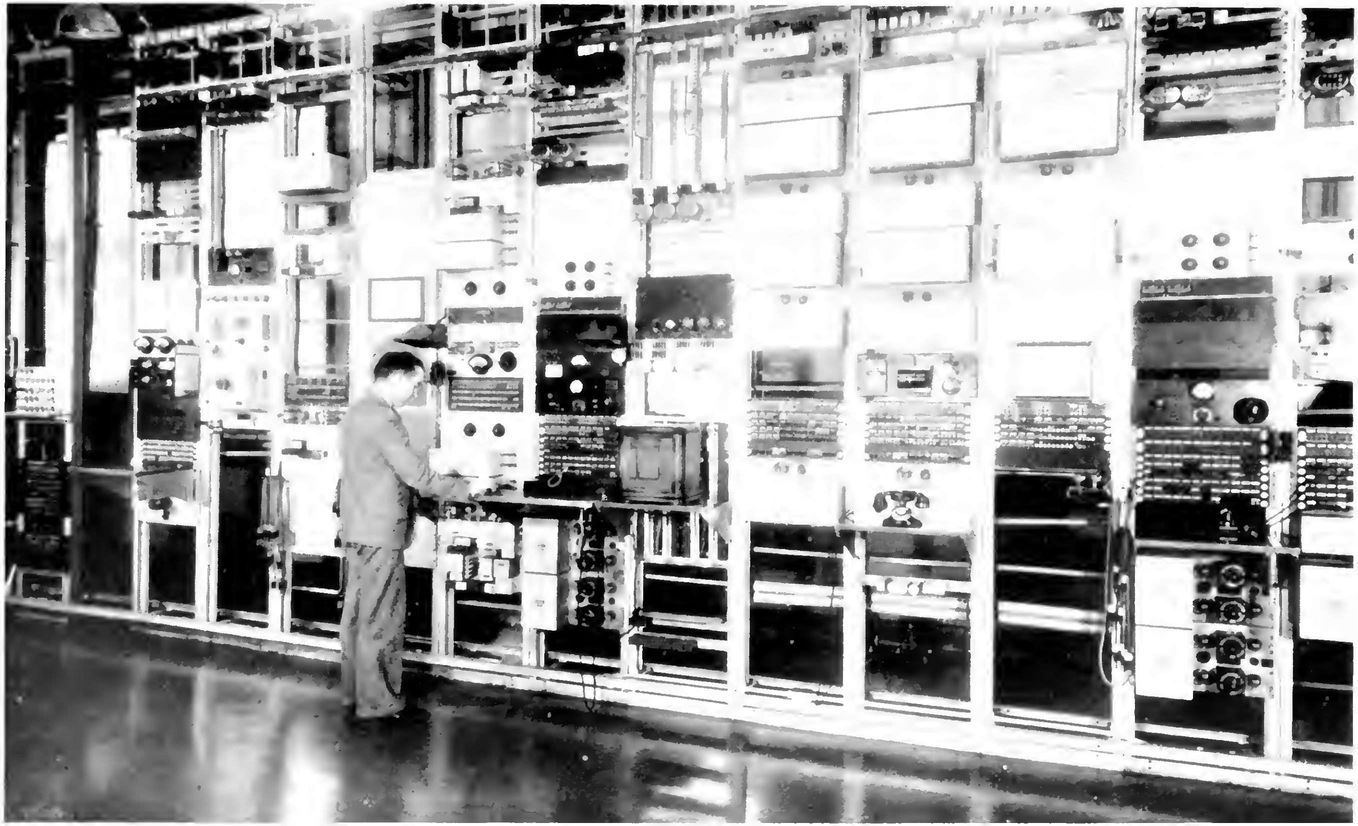


FIGURE 5. VIEW IN ONE OF THE MANY TELEPHONE CONTROL OFFICES CONCERNED WITH NETWORK SERVICE (DES MOINES).

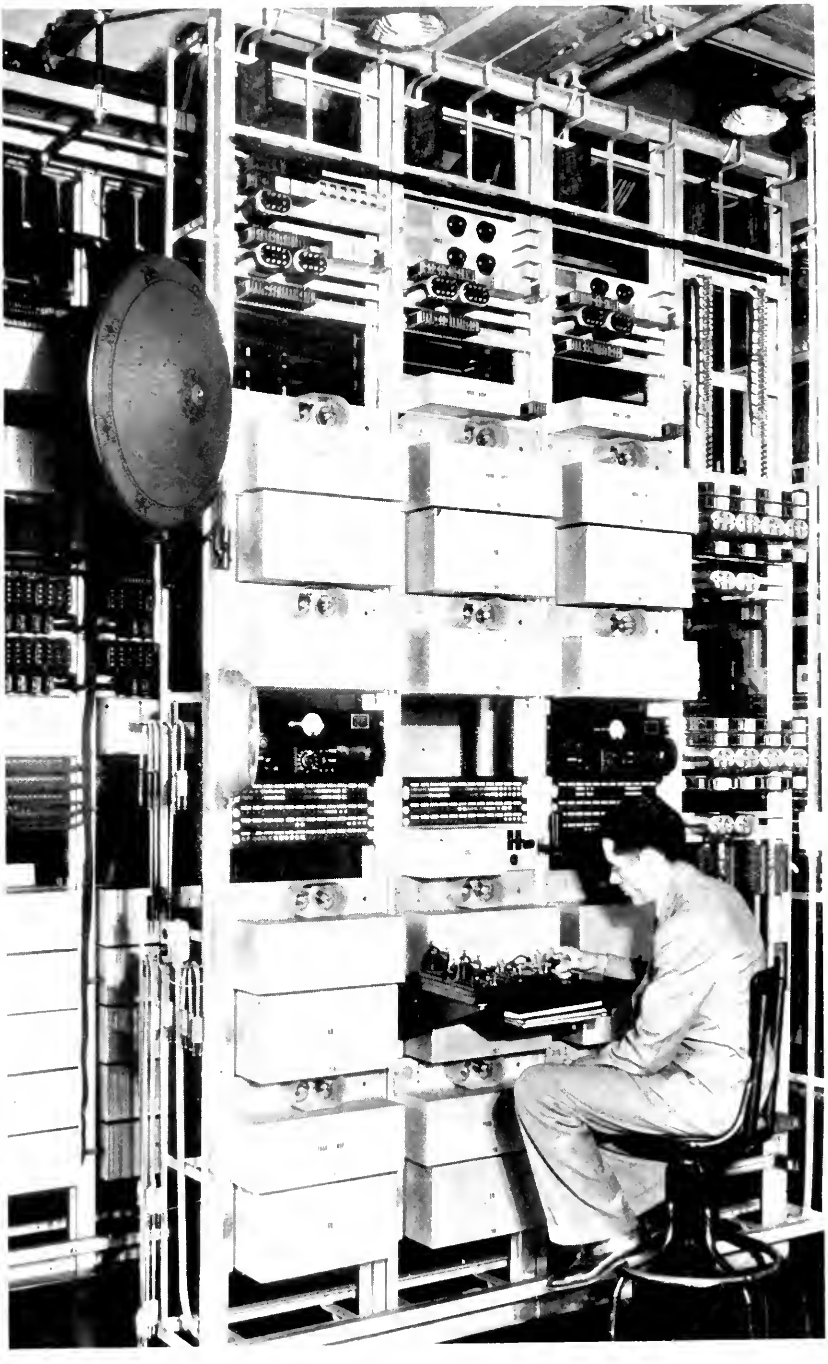


Figure 6. In the Course of Its Journey Along Wires, a Radio Program Passes Through Numerous Telephone Company "Repeater" Stations. Here, as the Term Suggests, the Weakened Currents are Amplified to their Original Strength and Quality, and are Sent Along to the Next Such Station, Where the Process is Repeated.

more loading coils with higher overall costs are used, and phantom circuits cannot be obtained. On the whole, the cost of broadcasting circuits, if used for message purposes, would be more than twice as great as circuits which are regularly used.

About 85–90 per cent of the facilities provided by the Bell System for program transmission service is furnished by the Long Lines Department of the American Telephone and Telegraph Company. The figures given below for wire mileages, expenses, revenues and so on are for the Long Lines Department only. For the other Bell System units where facilities are provided exclusively for program transmission service, the relations between investment, expenses and revenues will not differ widely.

At the beginning of 1934 the investment in plant used solely for network service totalled approximately $19,500,000, of which aerial wire plant amounted to $8,400,000, cable plant $7,400,000, and equipment $3,700,000. On a per circuit mile basis the aerial wire investment is $318, the cable $250. These figures are for all circuit facilities set aside for program transmission, whether fully equipped for service or not. If only those circuit facilities which are used on a full time basis are considered, the investment per circuit mile is $500 for aerial wire and $620 for cable.

On the side of expenses, excluding return on investment, the annual charges of the plant devoted to program transmission service, other than operating, amount to approximately $1,800,000. This figure represents charges for depreciation, maintenance, administration, taxes and insurance on outside plant equipment and buildings. The composite percentage of these annual charges is 9 per cent on the total investment. If only that plant in day to day use is considered, the annual charges become 12 per cent on the investment.

The annual expense to the Telephone Company for operating the regular and occasional networks during 1933 was $1,200,000. The total annual cost to the Telephone Company of furnishing networks for program transmission is therefore approximately $3,000,000 without allowance for return on investment.

The revenue from program transmission service in 1933 applicable to the facilities discussed in the foregoing was approximately $3,500,000. This revenue was derived from the line and station service charges for full time, recurring, and special occasion services. Something more than two-thirds of the revenue was derived from the full time services.

The estimated earnings in 1933 on program transmission service were approximately $500,000, which represents a return on investment of about 2½ per cent. If it were possible to sell sufficient program transmission services at existing rates to occupy to the fullest practicable extent all the facilities which have been provided exclusively for network purposes, it is estimated that the net return to the Telephone Company on its investment would be about 9 per cent.

This investment of the Long Lines Department has been made as a direct response to the demands for better and better programs over the air. This means, as far as the Telephone Company is concerned, that a high type of musical entertainment must be carried for hundreds and some times thousands of miles to all parts of the country, without any appreciable loss in fidelity and tone. (All sudden emergencies must be foreseen and provided against, so that a listener may not be disappointed, when he tunes in to get a particular program at a particular time.)

It may be expected that as time goes on these requirements will become more and more exacting. Due to the complex requirements of program transmission service, it can never become thoroughly standardized. In general, however, its activities can be charted in advance. For the rest, the many sided problems which constantly arise are dealt with immediately and with all the precision that care, experience and foresight can provide.

FIGURE 7. RADIO PROGRAMS GENERALLY TRAVEL THROUGH CABLE AS LONG AS THEY ARE EAST OF THE MISSISSIPPI RIVER. THESE "COVERED HIGHWAYS" AFFORD A HIGH DEGREE OF PROTECTION AGAINST WEATHER HAZARDS

Figure 8. Between Omaha and the West Coast, Radio Programs Pass, in the Main, Along Open Wire Lines Carried on Poles, Rather Than in Cable. A Typical Scene Along Such a Route is Shown Above.

Program transmission circuits provided today must stand the test of tomorrow's requirements. Every reasonable index as to possible future trends must be considered. Continuous attention must be given to possible future developments and the requirements which may grow out of such developments. This work is carried on by the Telephone Company in conjunction with the broadcasting companies, regulatory bodies concerned with radio broadcasting and other interested parties, to the end that the best and most economical design of circuits can be determined on. Such continuous and coördinated attention to the possibilities of the future insures that methods are fully adequate when new requirements are to be met. Furthermore, the plant, which is continually being added to or rearranged, is designed and installed with due regard to the possibilities of these future requirements.

An illustration of the work which is being done to provide for tomorrow's requirements was the reproduction in Constitution Hall at Washington, on April 27, 1933, of a symphony concert produced in Philadelphia by the Philadelphia Orchestra of more than one hundred instruments. For this demonstration, which was described in the July, 1933, issue of the Bell Telephone Quarterly, three specially arranged program transmissions circuits were used. Each was capable of transmitting the entire range of frequencies from 40 to 15,000 cycles per second. Further, the attenuation of all frequencies within this range, which is about three times the width of the bands now used in radio broadcasting, had to be equalized. Otherwise a faithful reproduction of the concert would have been impossible. Likewise, each circuit had to be free from all electrical disturbances in order to prevent any interference with the music.

The demonstration was unique in several important respects. Practically the entire audible range of musical tone was faithfully transmitted. A greater range of volumes than ever before attempted was placed under the control of the Musical Director. Using specially arranged volume controls, he was able to create tonal effects not possible with the largest orchestras. The sound output from the reproducing loud speakers at times exceeded that which could be produced by a one thousand piece orchestra. At other times the sound was reduced until it was barely audible. By the use of three separate transmission channels covering the left, the right and the center of the orchestra in Philadelphia, the illusion of depth and arrangement of the musical instruments was produced on the empty stage at Washington. The orchestra seemed to be actually present in Washington, although it was 130 miles away in the Academy of Music at Philadelphia.

Circuits of the kind described above, while not now available for use on a country-wide basis, can be made available should commercial requirements develop.

The process of looking ahead to tomorrow's requirements is continuing. The engineers and the operating men connected with program transmission service have endeavored to be at all times in advance of developments in broadcasting. The wire networks and the operating personnel have been ready to meet new conditions as they have arisen.

The ultimate goal, of course, is reproduction of music and speech in the listener's home—wherever located—so nearly equivalent to the actual program that there will be no perceptible difference. Recognizing its responsibilities in providing its share of this service, the Telephone Company is planning its plant and operating procedures with this objective in view.

G. S. Bibbins

Teamwork at Anderson, Indiana

A CENTRAL office serving 5,500 telephones wiped out by fire and completely replaced by a new central office in a new location in less than two weeks: that, in brief, is the story of what happened recently at Anderson, Indiana.

Anderson is typical of hundreds of other towns in the United States: population something less than 40,000; factories for the making of electrical goods, tools, automobile accessories and other products; a trading center that supplies the needs of the surrounding agricultural region; schools, churches, hospitals and homes; people going about their business and professional lives and their social activities very much as Americans do everywhere, telephone service, up to the early morning of Monday, January 29, 1934, being taken as a matter of course.

A few minutes after one o'clock on that morning in January, two night operators were at work in the Anderson exchange: quite enough to handle the small amount of traffic on the switchboard as all but a few of the people of the city slept. Below, in the lobby, the night elevator man sat reading a book. As he glanced up, he became aware of a curious red glare in the windows of a drug store across the street. He stepped out to investigate, found that the light was reflected from a fire that had broken out in a department store on the first floor of the building from which he had just come. The blaze was rapidly gaining headway.

By daybreak, the local and long distance switchboards were merely masses of twisted and blackened metal, the plant and traffic records had been reduced to ashes. All of the 5,500 telephones had been cut off from communication with each other and with the outside world. A city's telephone service, which had taken years to build, had been rendered useless in a night.

A gigantic task, considering the time element, now lay before the telephone company—an emergency that would test the organization's ability to mobilize materials and men to tackle a difficult problem and solve it, swiftly and surely.

On Sunday, February 11, at 11:30 P.M., a few hours less than fourteen days after the fire had been discovered, the job was finished and service was permanently re-established. A new exchange, in another building, had been installed and all telephones were receiving service just as if there had been no fire. These were the results of two weeks of intensive activity on the part of the organizations of the Indiana Bell Telephone Company and the Western Electric Company, aided by the facilities of the Bell System as a whole. To these results, important contributions were made by material suppliers outside the Bell System, transportation and express companies, newspapers, printers, hotels, and the city officials and people of Anderson, all of whom gave splendid co-operation during the entire period of the work.

Emergency Service

More urgently important, from the standpoint of time, than the problem of permanently restoring service was that of providing emergency equipment to meet the most pressing needs of the city while the wrecked exchange was being replaced. These two phases of the work went on simultaneously, but the provision of temporary equipment will be discussed first and then consideration will be given to some of the outstanding phases of the work of permanent restoration.

At the height of the fire, some three hours after its discovery, it became apparent that the loss of the central office would be complete. Steps were taken immediately to establish emergency service, and valiant work was done by the operators in this connection, as was also the case when the fire started. Telephones were connected to toll lines at the nearest practicable point in the outskirts of the city where these toll circuits were easily accessible. This arrangement connected Anderson with the outside world and the service it provided was available in the early hours of the morning of the fire.

At the same time, work was begun on the installation of small sections of switchboards in the telephone company's business office, a block away, and by afternoon long distance circuits to Indianapolis and Muncie, Ind., were available for those who wished to come to the office to make toll calls. Further long distance facilities were rapidly added to cover other routes.

Emergency service was also established on a magneto switchboard for a limited number of local telephones serving points which, in the public interest, particularly required service during the crisis. These included the police department, fire stations, sheriff's office, hospitals and newspapers, which were equipped with magneto telephones so that they might "carry on" until service had been permanently restored. As rapidly as possible this type of service was extended to other strategic points in the city.

Many private branch exchanges, which had normally been supplied with electrical current from the storage battery plant at the central office, were quickly equipped with local batteries so that, even though outside calls could not be made, intercommunicating service on the premises of the subscribers could be given.

Problems Involved

Something of the problems involved in the work of providing temporary service and in that of permanent restoration may be seen by reference to the accompanying sketch (Figure 1) showing the location of the former central office, in the Citizens Bank Building, and that of the new central office, in the Paramount Theater Building, together with the cable ducts leading to these two buildings. The business office on Twelfth Street is also shown. In the alley between the bank building and the theater building is a manhole through which all the underground cables passed in reaching the former central office. A temporary cable was run from this manhole, through the basement of the theater building, to the business office and there connected to the temporary switchboards. Circuits through the temporary cable were then extended by selecting pairs in the existing underground cable, which would lead to

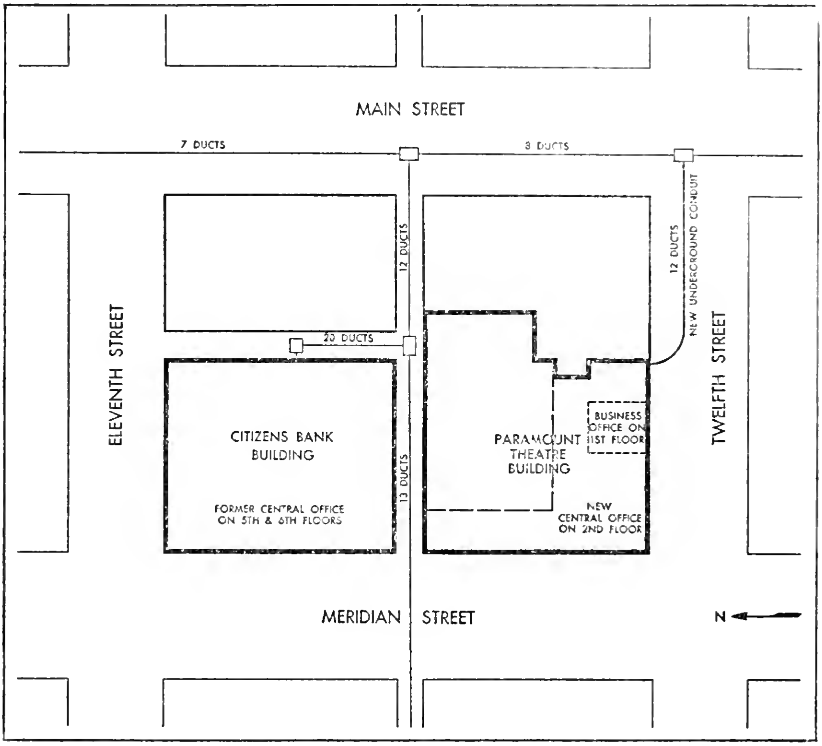


FIGURE 1. THE LOCATION OF THE OLD AND NEW CENTRAL OFFICES.

the desired points at which temporary service was to be provided. Although this arrangement was convenient, the work was made unusually difficult by the zero weather conditions existing at the time.

Turning now to the problem of establishing permanent service, it may be well to glance again at the sketch showing build-

Figure 2. The Local Switchboard in Anderson as it was Before the Fire.

Figure 3. What was Left of the Local Switchboard in Anderson on the Morning of January 29.

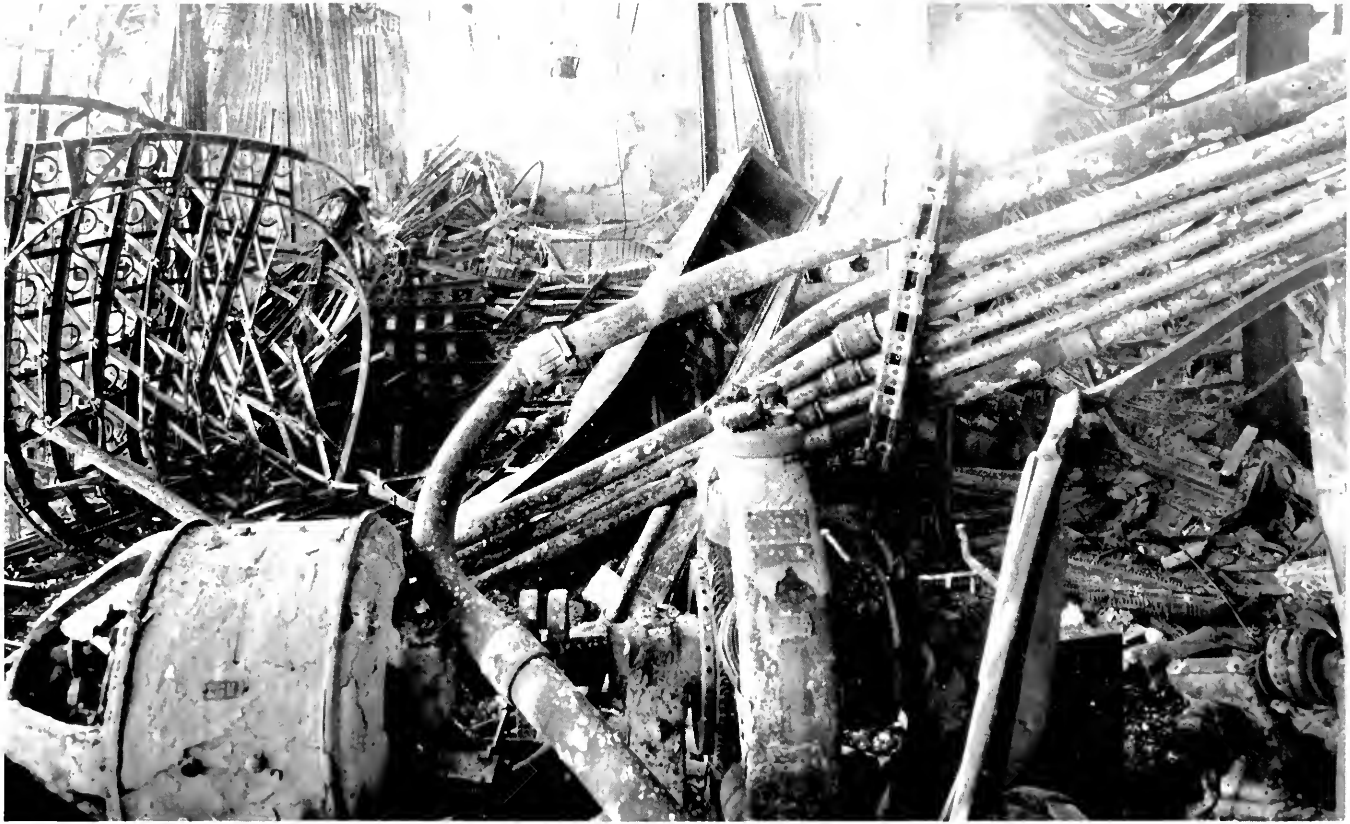


Figure 4. The Terminal Room of the Anderson, Ind., Exchange After the Fire.

ing locations (Figure 1). The Citizens Bank Building, in which the telephone exchange was located, was a six-story structure of steel, brick and tile, with concrete floor slabs. The fire was reported to have started on the first floor, traveling upward to the roof. It was confined to the ground floor and to the south and east portions of the upper floors. The combustible portions of the building, consisting of window frames and sash, doors, interior trim and floor coverings, together with the contents of the south and east portions of the building, were totally destroyed. Figures 2 and 3, showing the former local switchboard before and after the fire, give some idea of the destruction resulting from the blaze. Two smaller buildings on the east side of the bank building were burned. The Paramount Theater Building, in which the telephone business office is located, was unharmed.

Preliminary Plans

Plant men at the scene of the fire had no sooner reported to headquarters of the Indiana Bell Telephone Company at Indianapolis that the exchange would be completely destroyed, than preliminary plans for a new one were under way. A small group of equipment and traffic engineers was assembled and data from the Anderson office, on file at headquarters, were examined. This study indicated that a Western Electric Company No. 11 Type switchboard should be secured if available. Reversing the usual procedure followed in normal installations, the engineers decided to order the switchboard, main distributing frame and miscellaneous equipment at once and find a place in which to install this apparatus while it was en route. The detailed engineering would be done as soon as a suitable location was obtained and dimensions could be determined.

Negotiations were immediately undertaken for the leasing of suitable space, the possibilities of several locations being developed simultaneously. The Paramount Theater Building was selected as the most desirable, the building being well located close to the site of the former exchange and consequently to the center of the established underground cable systems. It offered about 7,000 feet of floor space on the second floor, without existing partitions and with adequate ceiling height. The building is of reinforced concrete construction, with brick exterior walls and has metal windows with wired glass in the exposed areas.

While the negotiations for the new building space were being carried on, a complete layout of the theater building space, drawn to scale, was shipped to the Kearny, New Jersey, works of the Western Electric Company, by air mail. Before work on certain portions of the equipment could be started, specific dimensions of the room in which it was to be installed were required. These plans were accordingly sent, with instructions to begin work immediately on advice that the lease for the new exchange space had been executed.

Service of Supply

Few more convincing proofs of the efficiency of the Bell System's "service of supply" could be found than that provided by even a cursory examination of the problem which confronted various branches of the Western Electric Company as a result of the fire, and of the manner in which this problem was handled.

A major part of the equipment supplied came from the Kearny works of the Western Electric Company but, before the job was done, sources of supply located in fourteen different cities had contributed to the installation of the new office. These included the Kearny works and those of the Western Electric Company at Hawthorne, Illinois, and Point Breeze, near Baltimore, Maryland, and its Indianapolis distributing house. But they also included outside suppliers located at such widely scattered points as Fort Wayne, Indiana; Newark and Bloomfield, New Jersey; Lynn and Pittsfield, Massachusetts; Philadelphia, Pennsylvania; Detroit, Michigan; and New York City, Mount Vernon, and Schenectady, New York.

At one point or another, every operating department of the Western Electric Company participated in carrying some part of the work through to completion. The crews most vitally concerned lived with the job until they saw it finished.

To the equipment engineers of the Kearny plant fell the exacting task of engineering the new switchboard, issuing specifications to the plant and to the installers in the field, ordering the material needed from outside suppliers and so arranging the whole job, from start to finish, that the installers on the scene would receive the apparatus as nearly as possible in the sequence in which they needed it.

Ready for Shipment

Under the Western Electric Company's present set-up, the major units of equipment for an office of the type which was to be installed in this case are carried in stock and are ready for immediate shipment. The problem, therefore, of the equipment engineers was to adapt the stock equipment on hand to the conditions peculiar to Anderson. The fact that such a stock was on hand made it possible to ship the material so that it was available as quickly as it could be used by the installation force.

Formerly a fire emergency stock was carried, but this practice was discontinued several years ago, when the plan of carrying switchboard sections and other units in stock was inaugurated. The new plan proved its adequacy in this emergency, not only by making prompt shipment possible but by providing equipment that was better suited to the needs of the particular location in which it was to be used than would have been possible with the fire emergency stock.

Nevertheless, an enormous amount of work had to be done, and done at top speed, in order that material might be shipped at the earliest possible moment. No switchboard multiple had been manufactured at Kearny for some time and only one operator skilled in this work was on duty at the plant when the order was received. By telephone, telegram and automobile, a crew of forty-nine men was assembled, including nine central office installers from the New Jersey area. The factory cabling job involved 42,000 jacks and lamp sockets. Connecting each of these to the cable required twenty separate operations such as cutting, waxing, skinning, forming, sewing, fanning, soldering and inspecting—a total of 840,000 individual operations. Various wired units which are ordinarily made on manufacturing schedules of from six to ten weeks were turned out in twenty-four to forty-eight hours.

High-Speed Manufacturing

As has been said, news of the fire reached Kearny on Monday morning, the day of the fire. On Tuesday, the first consignment, including standard units of the switchboard, bulk cable and much of the material available in the Merchandise Department was shipped. This shipment weighed 25,000 pounds. By noon on Wednesday, the floor plans of the new exchange had reached Kearny, word had been received by telephone that the lease had been executed and the job of engineering and producing the multiple began. The multiple was manufactured in layers and shipped in sequence, so that the installers could lay it from the bottom up. In other words, as soon as the installation crew was ready to work with a specific piece of equipment, this equipment was on hand, ready for use.

Almost as noteworthy as the work done at the Kearny works was that of the Point Breeze plant in handling an order for a length of quadded cable required to extend the long distance circuits into the new office. The order for this cable, which included 359 pairs of wires, was received on the morning of the Thursday following the fire. Machinery was put in motion at once and, due to the advanced methods of manufacture developed by the Western Electric Company, the cable was completed by Saturday forenoon. A special car was provided and the cable left Baltimore Saturday night. It reached Anderson on Sunday evening, and within an hour after its arrival it had been pulled into the underground ducts leading to the new central office.

The problem of arranging transportation for all this material was, in itself, one of major importance. This phase of the job was handled by the Traffic Department of the Western Electric Company. Six shipments were made by air mail. These consisted mainly of drawings and specifications for the use of the installers. One of the last consignments of apparatus, however, was carried by air mail and arrived in time to make the cut-over possible as scheduled. With this exception, all material and equipment was shipped by express, in several cases in special cars which had to be arranged for in advance.

Speeding Up Shipments

Ten hours' traveling time was saved on all shipments out of the Kearny plant by having them trucked to New York City, from which there are a number of passenger trains a day that connect directly with Anderson. For eleven days, these trains carried in regular or special express cars Western Electric material destined to take its place in the new telephone exchange. In all, over 105,000 pounds of apparatus and supplies were shipped from various points, of which nearly 80,000 pounds came from the Kearny plant. The Hawthorne plant shipped over 10,000 pounds, including cable and equipment and a large proportion of the tools and testing apparatus used on the job.

The material in Hawthorne's shipments was so vitally important that upon its prompt arrival depended the uninterrupted progress of the work at Anderson. Hawthorne met every demand and filled requests as rapidly as they came. Virtually every order was shipped the day it was placed and arrived at Anderson the next day.

Many instances could be cited. Shortly after closing time on February 2, an order was received for forty-two test sets required the following day. A crew worked late into the night calibrating and checking and before morning of the next day, the sets were packed and on their way.

The most urgently needed testing equipment was loaded into the car of a Hawthorne official who drove it to Anderson and stayed on the job acting as contact man between the factory and the installation force.

Mobilizing Man-Power

So much for the Western Electric Company's really remarkable work in mobilizing materials for this important emergency job. What it did in the mobilization of man-power was hardly less noteworthy. By telephone and telegraph the summons for installers went out to surrounding areas. Soon these expert craftsmen began to arrive: thirty-five from the Chicago area, fifteen from the Detroit area, twenty-nine from the Cleveland area. In addition, twenty-one ex-employees were recalled from the nearest points. When the installation job was in full swing, 100 installers were on duty, working in three eight-hour shifts. Day and night, without let-up, they kept at it, working as closely together as was possible without interfering with each other, as is shown in Figure 5.

While this "service of supply" was functioning as just described, the outside plant force of the Indiana Bell Telephone Company was also doing a most noteworthy piece of work. As has been said, these men appeared on the scene while the fire was still under way and took the initial steps toward the restoration of service. They also had heavy responsibilities arising out of the provision of temporary service during the emergency. But the problems involved in preparing, in advance, to connect the new exchange with the existing cable system are of particular interest. What these problems were, and how they had to be solved, will become somewhat more

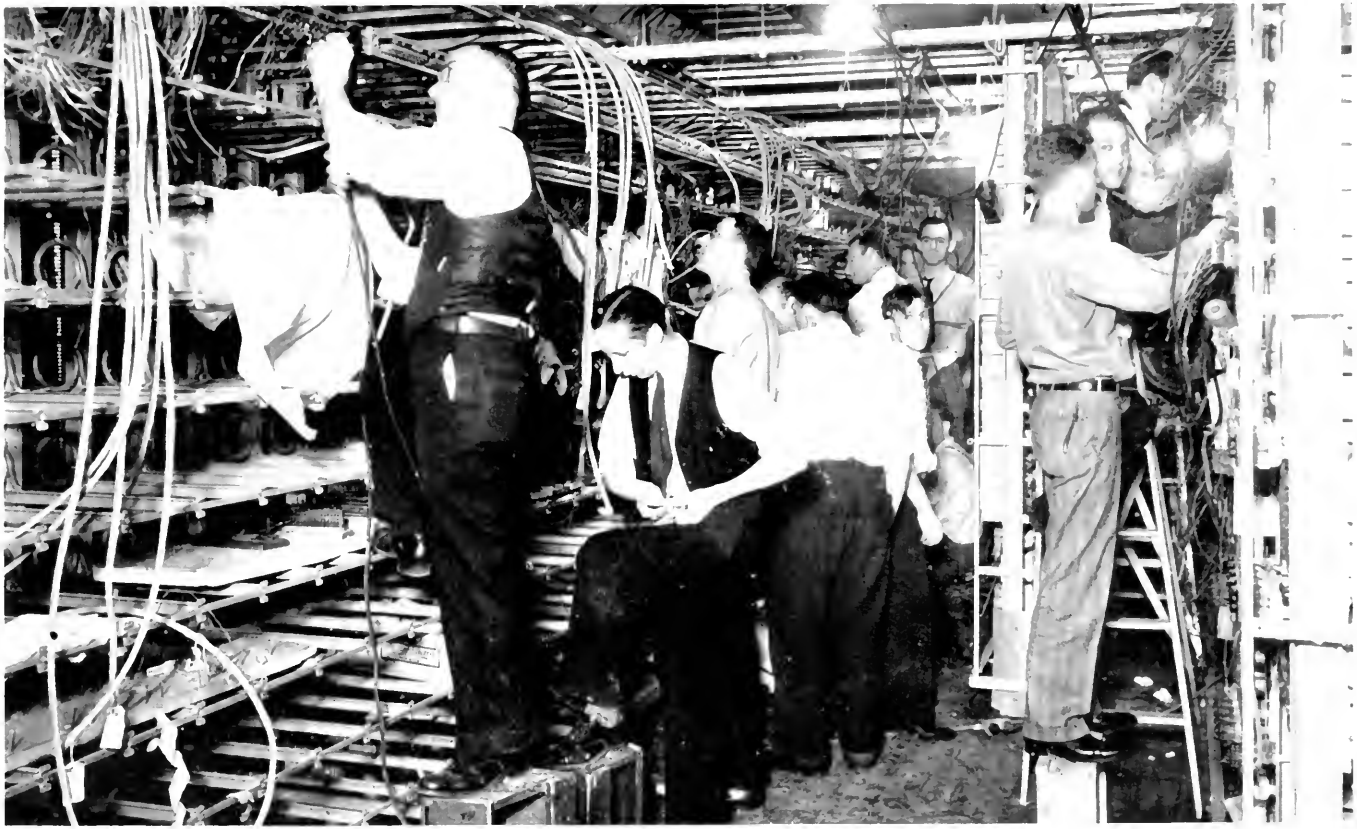


Figure 5. Some of the 100 Western Electric Installers Working on the Horizontal Side of the Intermediate Distributing Frame and Relay Racks.

FIGURE 6. PART OF THE CROWD THAT ATTENDED THE "OPEN HOUSE" HELD ON THE EVENING OF FEBRUARY 13 ONE DAY AFTER THE SERVICE WAS RE-ESTABLISHED.

clear to the reader who is not familiar with the details of the telephone business, if a brief description is here given of the telephone cable plant in a city of the size of Anderson.

Plant Records Destroyed

One of the dominating features of a central office is the main distributing frame. It is the meeting point for the wires from the outside plant, which radiate to the homes and offices of the subscribers, with the wires leading to the switchboard. On one side of the main frame, the wires leading to the switchboard are permanently soldered to numbered terminals corresponding to the numbers of the switchboard, which are the numbers assigned to the subscribers and published in the telephone directory. On the other side of the main frame, the pairs of wires which enter the office in cables, stretching out to all points in the city, are soldered to terminals bearing permanent numbers, called the cable-pair numbers. With this arrangement, any cable pair may be connected to any switchboard number by placing cross-connecting wires through the main frame.

Each cable pair extends from the main frame out through the underground and aerial cables, and appears again at a cable terminal, somewhere in the city, bearing its proper pair number. These cable terminals may be located in the larger buildings, where there are a relatively large number of telephones to be connected with the system, or on poles in the streets, alleys or other points throughout the city. In any case, the cable terminal is the point at which the line running to the subscriber's telephone is connected to the cable system.

This description will perhaps give point to the statement, earlier in this article, to the effect that in the Anderson fire all the telephone plant records were completely destroyed. In every telephone area, the whole system of cable distribution is carefully planned and a detailed record kept of the location of every outlying cable terminal in the city and the individual numbers of the pairs which appear in that terminal. This record reveals, also, the pairs which are idle and those which are in service and, in the latter case, the switchboard number to which it is cross-connected on the main distributing frame.

These records had been destroyed. Not only the local and toll switchboards, but the main distributing frame and the cables which entered the former telephone office lay in a tangled mass. The wires of these cables were connected at their distant ends to cable terminals somewhere in the city—nobody knew where. The identity of each pair had to be discovered. This was done by testing through to the outlying cable terminals, where the number of each pair was available. This work, known as "tagging," was carried on by crews of cable splicers and their helpers.

New Cables Laid

Meanwhile, it was necessary to link the existing cables, which had formerly led to the old office, with the new location. As soon as the location of the new office had been determined, excavation work was started on Twelfth Street for the subway, or system of underground ducts through which the cables were to be run, that would intercept the Main Street route and extend the underground system to the new office. The work of excavating and constructing the extension and replacing the paving was quickly accomplished. "Quick-setting" cement was used and artificial heat was applied to prevent its freezing. Five cables, each containing 1,800 pairs of 26-gauge wire, for use in this extension, had to be ordered and delivered and were immediately pulled through the new subway and terminated on the new main frame.

While this was being done, the work of "tagging" went on. The new cables were spliced to the existing ones. When splices were completed, each pair formed an unbroken metallic circuit from the outlying cable terminal to the main distributing frame and bore the same number at either end. But another job, not less important, had still to be done. Until the telephone numbers of the subscribers, who were connected at the distant ends of the cable pairs, were ascertained, they could not be cross-connected to their proper numbers on the switchboard. One method of obtaining this information would have been to wait until the cables had all been connected through to the main frame and then to ring out from the central office, securing the telephone number from the subscriber who answered, and making the necessary cross-connection records from the data thus obtained. This would not have been a difficult job, but it could not have been undertaken until the cable work had been completed. Time was precious and it of course was necessary, wherever possible, to overlap operations in order to speed up the completion of the job. To accomplish this result, a field canvass was made, the record of telephone numbers with their related cable pair-numbers was reconstructed, and cross-connection wires were placed on the main frame while the cable work was still in progress.

Co-ordinated Activities

Other activities had to be co-ordinated with those already described and with each other—all of them concerned in one way or another with the job of restoring service and being certain that, when restored, service would be as good as it was possible to make it. The new space was arranged to meet the requirements of a telephone office; an underground entrance was constructed for the cables, with ducts leading to the second floor; reinforcement for floors was provided at points where it was made necessary by the installation of the heavier parts of the equipment; a rest room was provided for the operating force and fully equipped; plumbing was installed and the electric wiring rearranged to meet the special requirements of the operating room.

A new telephone directory was necessary, due to the fact that the switchboard multiple numbers would not run as high, numerically, on the new switchboard as they had on that which it replaced. Some of the subscribers' numbers, accordingly, had to be changed. The new directory was printed and distributed to subscribers before the new exchange was cut over for service.

Information bureau records, long distance rate and routing instructions and other local traffic records—all of them vitally essential to efficient service—were reproduced. The operating force was instructed in unfamiliar features of the new switchboard. When 11:30 arrived on the night of February 11, everything was ready and the exchange was placed in service.

On February 13, the people of Anderson thronged the new central office building, not merely to see the results of these fourteen days of labor, but to express their appreciation for the manner in which this work had been done. City officials and the business and professional men of Anderson were enthusiastic in their praise of the telephone company for its record-breaking job of restoration. A number of business firms inserted paid advertisements announcing their new telephone numbers and expressing their admiration of the men who had brought the city, from a communication standpoint, back to normal.

The press was equally outspoken in paying tribute to the people of the telephone company. The *Anderson Herald,* in an editorial in its issue of February 13, said, in part:

> "To the telephone officials we all owe a word of thankfulness for the remarkable speed shown in re-installing a more modern system over the wreck of the old. Telephone officials inform us that a world record has been established in the installation of the new Anderson exchange in the two weeks since the fire completely destroyed the old."

In similar vein, the *Anderson Bulletin* said, on February 9, while the work was still in progress:

> "The telephone company is to be congratulated on its speedy action in restoring service in a comparatively short time. . . . Although lack of telephone service caused some individual inconvenience and proved a handicap to thousands of residents of the community, the public in general

took the situation philosophically, and as a result there has been little real difficulty."

This understanding attitude on the part of the public, and its active co-operation with the telephone company, were important factors in making the record-breaking reconstruction job a possibility.

VANCE OATHOUT

Editor's Note:

A fire on Saturday, March 10, which destroyed the department store of Loveman, Joseph and Loeb in Birmingham, Alabama, spread across the alley to the roof of the downtown telephone building which housed a switchboard serving some 8,000 stations, the long distance switchboard and positions handling information and other special services. The volume of water required to extinguish the fire in the roof and attic damaged the telephone equipment to such an extent that it was necessary to abandon this location for telephone service. The rapid restoration of toll service and of service to the 8,000 subscribers formerly served by the ruined office was an accomplishment of which the Bell System may well be proud, and it is hoped in the near future to include in the BELL TELEPHONE QUARTERLY an interesting description, by the Chief Engineer of the Southern Bell Telephone and Telegraph Company, of the way in which this problem, somewhat different from that encountered at Anderson, Indiana, as described above, was handled.

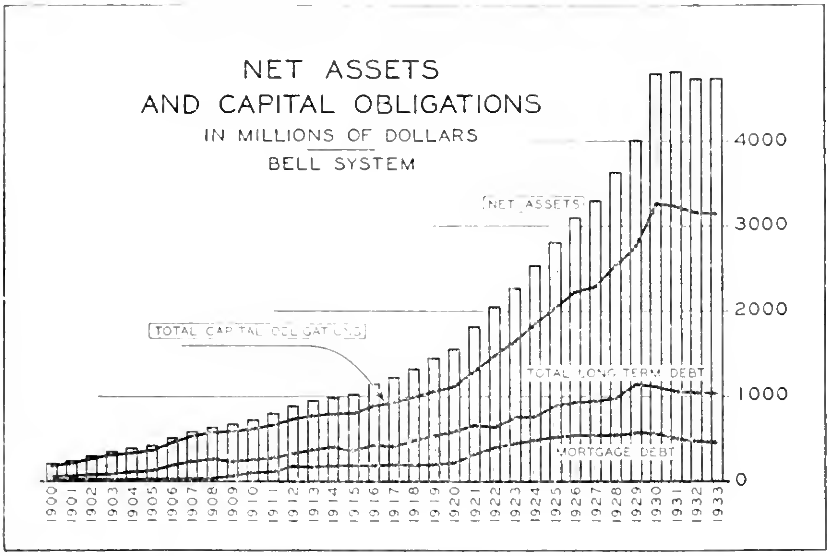
Owners of the Bell System

THE owners of the Bell System and their families, if they could be drawn together into a single community, would make up a city larger than Philadelphia. Fifty-eight years ago, however, when the first telephone was demonstrated at the Philadelphia Centennial, a skeptical public considered it a toy and few aside from the inventor saw any promise of public value in this new device.

By force of vision and private initiative, the small beginnings in the laboratory of Alexander Graham Bell evolved years later into a great national telephone system. This system, linking together more than 16,600,000 telephones throughout the United States, is now regarded as essential to the business and social welfare of the country. Certainly life could not go on at the present tempo without the telephone at our command.

A unified system such as is provided by the American Telephone and Telegraph Company and its Associated and Connecting Companies is as necessary to the nation as a common language. About 90 per cent of this telephone network is owned and operated by the companies comprising the Bell System; and through facilities which the Bell System provides for telephone communication with foreign countries, most of the world's telephones can now be reached from Bell-owned and Bell-connecting telephones. Thus the direct business descendants of the founders of the enterprise continue mainly responsible for the nation's telephone service.

The building of the Bell System covers a period of more than half a century, and at the present time nearly five billion dollars of investment are devoted to furnishing its telephone service. This construction of plant has been financed largely by issues of capital stock and bonds of the parent company of the System, that is, by the American Telephone and Telegraph Company; but a number of its 24 Associated Companies, each of which operates the local and interurban telephone lines in one or more states throughout the country, have also sold securities to the investing public.



Capital Obligations of the Bell Companies in the Hands of the Public at the End of 1933 Were Only Two-thirds of the Total Assets.

At the end of 1933 the capital obligations of the Bell System were held by some 850,000 investors. A general classification of these investors according to type of security held is given below:

	Security Holders	Par Value Held	Average Holding
Bell System Bonds	180,000*	$ 921,200,600	$5,100
Associated Company Preferred Stock	108,000	97,937,600	900
Associated Company Common Stock	33,000	133,147,700	4,000
A. T. & T. Stock	681,000	1,866,227,500	2,700
Total Bell System	1,002,000	$3,018,513,400	$3,000
Total excluding estimated duplications in holders	850,000	$3,018,513,400	$3,500

* Estimated

Thoroughly American in character, this investment ownership represents a true cross-section of the nation—the average citizenry in home and office, in workshop and on the farm, seeking to invest in a safe, productive enterprise.

The outstanding bonds of the System are owned to a large extent by banks, insurance companies and other institutions of fiduciary character which must invest in the more conservative types of securities. According to recent estimates, the United States has 25,000,000 or more life insurance policy holders and bank depositors, including those with thrift accounts. Their interest as lenders of capital to the System is undoubtedly unconscious, but in so far as their institutions have invested in the bonds of the System, their savings have indirectly helped to finance many million dollars of telephone construction. Outnumbering the institutional holders, but probably owning a smaller proportion of the System's bonds, are some 170,000 individual bondholders representing investors who follow the practice of keeping all or part of their funds in high grade interest-bearing securities.

Next in order of seniority are the 108,000 holders of Bell System preferred stocks which have been issued by eight Associated Companies. Sold for the most part since 1921 to investors in the operating areas of the respective issuing companies, and with average ownership at the low figure of but nine shares per holder, these preferred issues are widely held by people of moderate means.

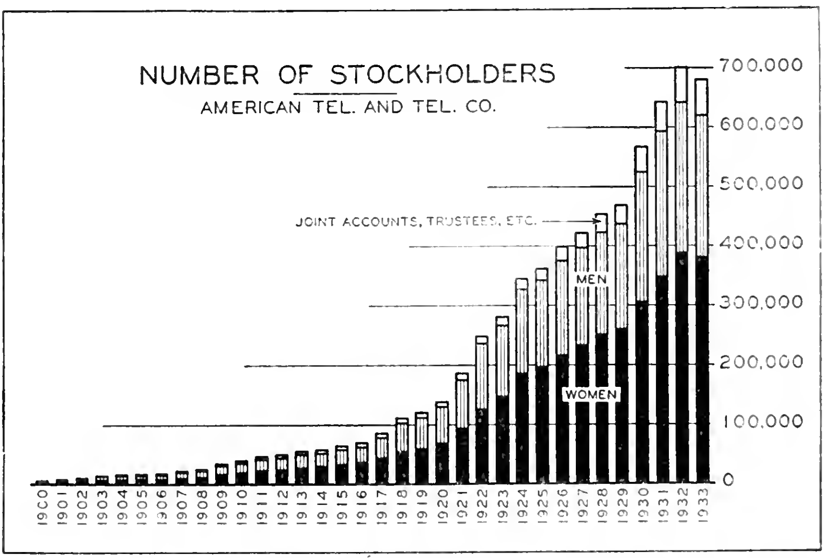
Although the A. T. & T. Co. owns nine-tenths of the common stock of its Associated Operating Companies, there are five of these companies which have some of their common stock outstanding in the hands of investors. The origin of this stock dates back to the earlier days of the telephone industry and, like the preferred stocks, such amounts of these issues as are outstanding in the hands of the public are held largely by investors in the territories of their respective companies. Some

33,000 investors hold $133,000,000 par value of such common stock, with an average holding of 40 shares.

A. T. & T. stock represents in large measure the stock of the telephone industry of the nation. There are 18,662,275 shares of this stock outstanding and it is all of one class with a par value of $100 per share. For this stock the Company has received an average of $114 per share, making it the opposite of "watered" stock. It is interesting that but one-quarter of one per cent of the shares now outstanding represents the original interest of the inventor of the telephone and his three associates who launched the enterprise, excluding the stock for which they later subscribed on equal terms with other stockholders. Speculatively or otherwise, there have been no telephone fortunes and even in boom times the A. T. & T. Co. has paid only reasonable regular dividends, the dividend of $9 per share paid in 1933 being about 6½ per cent on the stockholders' investment including surplus, or lower than the rate paid on many cumulative preferred stocks.

Through advances for construction, and the purchase of stock in its Associated Companies, the A. T. & T. Co. has supplied the greater part of the new capital required to build the telephone properties of the Bell System. Since the A. T. & T. Co. has raised four-fifths of the capital which it has needed for this purpose through issues of its stock, plainly its stockholders have had the chief responsibility for financing the System. During the decade of the System's greatest development, beginning with 1921, subscriptions for A. T. & T. stock brought in more than $1,600,000,000, representing nearly three-quarters of the total new capital secured by the Bell System in that period.

According to usual security terminology, bonds and notes are underlying securities, preferred stocks rank next and common stock ranks as the junior, or equity, security. From the standpoint of raising new capital, this order must be reversed. In other words, common stock is the foundation upon which all sound financing must be based, and the investment merits of this security largely control the success of future capital issues. Companies which are able to finance their needs with proper amounts of common stock are obviously in the best position to continue to raise new capital as required and to borrow money on favorable terms. Thus, the contribution which A. T. & T. stockholders have made toward financing the System's growth has been of fundamental importance to the nation's telephone users, for without the new capital provided by these hundreds of thousands of people it would have been impracticable to provide telephone service of the present scope or standard of convenience.



At the End of 1933 There Were 681,000 Stockholders with an Average Ownership of 27 Shares Each.

For the most part these stockholders are men and women who by their daily thrift have put aside small sums for investment, and thousands of them are now past their earning years. Based on an analysis made some time ago of 88,000 purchasers of stock through a plan offered by the Bell Telephone Securities Company, it is estimated that stockholders fall into approximately the following occupational groups:

Estimated Distribution of A. T. & T. Stockholders by Occupational Groups
Dec. 31, 1933

Bell System employees	115,000
Professional and technical	40,000
Educational	25,000
Clerks and sales people	90,000
Merchants	35,000
Trades and farming	25,000
Manual laborers	30,000
Management and financial	25,000
Government employees	15,000
Personal services	25,000
Retired	21,000
Housewives	210,000
Total individuals	656,000
Trustees	20,000
Corporations and private firms	5,000
Total A. T. & T. stockholders	681,000

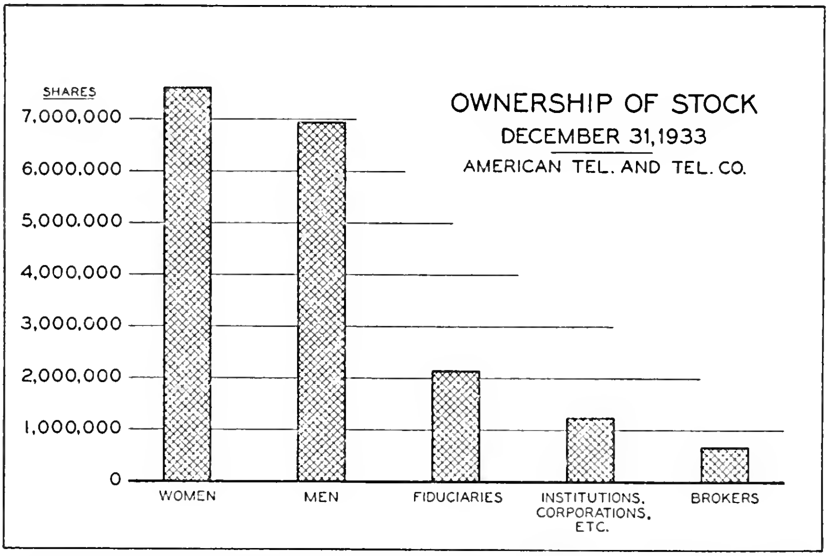
The largest single group in this occupational classification, excluding housewives, is composed of Bell System employees. Since its inception, employees have been stockholders of the parent company, but within recent years, through the purchase of stock under installment plans, they have greatly increased their interest. At present, more than 40 per cent of the employees own A. T. & T. stock and have thus chosen to put part of their savings into their own industry.

Some 20,000 trustees, executors and similar fiduciaries are registered stockholders. While their average holdings are only 74 shares each, they hold seven per cent of the stock. Banks and trust companies own an additional four per cent for others, perhaps chiefly for trust estates, which means that in all more than $200,000,000 par value of the stock is held in a fiduciary capacity.

About 5,000 institutions and corporations own A. T. & T. stock and the par value of their investment is more than $100,-

000,000. That this amounts to a substantial contribution from such sources to the stock financing of the System is obvious, but the character of these stockholders is of particular interest. Included in their number are 500 churches and religious organizations, 250 schools and colleges, 200 institutional homes and 150 hospitals.

Brokers' holdings of A. T. & T. stock have always been relatively small. At present, the list discloses about 490 brokerage firms with less than 3.7 per cent of the outstanding stock registered in their names. Although this represents, in a general way, the floating supply of the stock, actually it is smaller than this percentage indicates, for there is always a considerable amount of stock in brokers' names which is not in the market for sale.



Of the Stockholders at the End of 1933, Approximately 656,000 Were Men and Women, While the Remaining 25,000 Comprised Fiduciary and Other Accounts.

At times of heavy stock financing, security dealers have been important factors in stabilizing the market and in absorbing through their market purchases the portion of each new stock offer for which other stockholders have not subscribed. These new stock issues have not been underwritten in any way, but in the six offers made by the A. T. &. T. Co. from 1921 to 1930, brokers voluntarily bought subscription rights in the market from stockholders not wishing or able to subscribe, and thus with the rights they themselves received as stockholders they purchased a total of $191,000,000 par value of new stock. This sum which brokers subscribed for stock, in part for their clients, constituted 20 per cent of the total stock subscription under these offers and demonstrates the value to the telephone industry of having a stock which maintains its investment position.

There are, of course, a number of individuals who hold large amounts of A. T. & T. stock. For over forty years, however, no individual or small group has owned a controlling or even a relatively substantial interest in the stock of the A. T. & T. Co. or its predecessor, and now no individual stockholder has as much as one-fifth of one per cent of the stock outstanding.

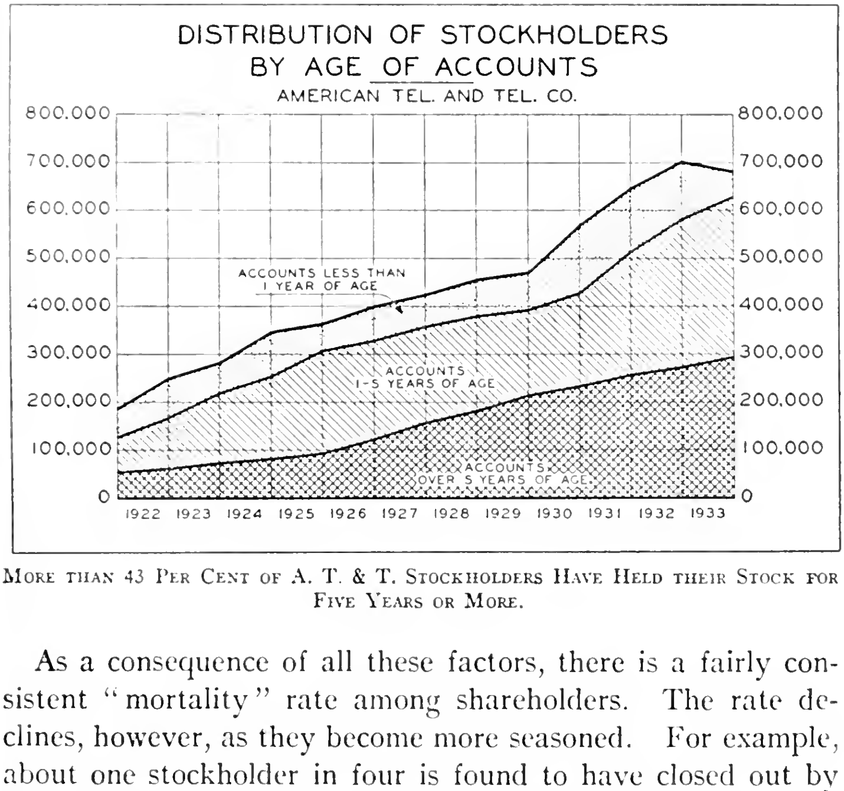
Geographically, A. T. & T. stock is perhaps the most widely held single investment in the world. During earlier years the ownership of stock was naturally centered in Massachusetts, where the telephone was invented and first financed, but as the Bell System grew and its nation-wide character became established, interest in its securities extended to all parts of the United States. Furthermore, it was soon recognized that the telephone industry could not be financed through the savings of any one section of the country and that a broad interest in the Bell System would be needed to provide the capital funds required for its growth. There are now twelve states which each have more than 10,000 stockholders. Twenty-three states have more than 5,000 stockholders and no state has less than 500. There are 8,000 stockholders, or 1.2 per cent of the stock list, owning 2.7 per cent of the total stock, in 82 foreign countries and United States possessions.

While farming areas and small centers of population have done their part in supplying the capital needs of the telephone business, there is also a wide distribution of the stock in cities. In fact, the ten largest cities of the United States account for a total of 200,000 holders. New York City alone has some 80,000 individual owners of the stock, or one owner for every 60 adult persons as compared with one owner for every 100 adults in the United States as a whole. Conservative estimates indicate that the total number of all people holding corporate stock in the United States is about 5,000,000. If this is true, about one in seven of these owns A. T. & T. stock.

From the first, a large proportion of stockholders have individually owned but a small number of shares. At present, owners of 25 shares or less comprise 80 per cent of the stock list, and some 260,000 of the stockholders, representing 40 per cent of the total, own five shares or less. As a result of this widespread ownership of stock in small holdings, there is an unusual democracy of interest in the business which, on the one hand, relieves the Company from possible dominance by small groups of stockholders and, on the other hand, provides a broad base for financing future capital needs.

Investors who have been able to buy only a small number of shares at a time have, none the less, had a vital part in new financing. By and large, these stockholders have taken more than their pro rata quota of new stock offered for subscription and since 1921, $200,000,000, or more than one-fifth of the total amount received under these offers, has been provided through subscriptions for five shares or less.

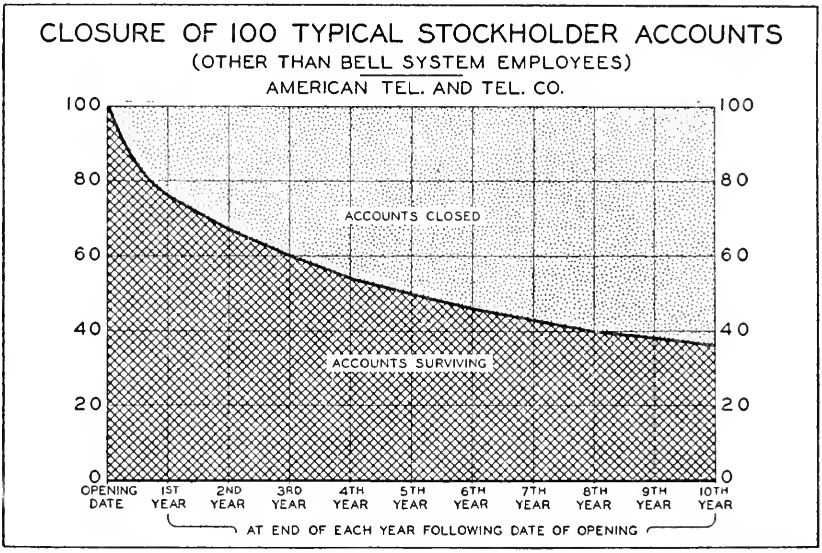
In any large investment list there is, of course, a continual turnover in individual holders. Death and the distribution of estates is an ever present factor in this turnover and in the case of the A. T. & T. Co. some 5,500 stockholder accounts are closed out yearly through this cause alone. Allied with this is the turnover due to gifts of stock to others. But there is a greater turnover due to the selling of stock by stockholders because they need funds or are attracted by some other investment. From the standpoint of these potential sellers, it is desirable that the stock have a ready market and that it be not subject to abnormal fluctuation. It is this very fluctuation in price, however, that unsettles and constantly works out of the list another and perhaps less numerous group of stockholders—those who are not well established in their savings habits—who are watching the market for current profits, or who may be uneasy about their investments in the face of day-to-day market developments.



More than 43 Per Cent of A. T. & T. Stockholders Have Held their Stock for Five Years or More.

As a consequence of all these factors, there is a fairly consistent "mortality" rate among shareholders. The rate declines, however, as they become more seasoned. For example, about one stockholder in four is found to have closed out by the end of a year, whereas in the second year only one in every eight of those surviving will have closed out, with generally lower rates of loss thereafter.

These rates represent only average tendencies, however, because the actual turnover definitely varies from year to year under the impact of influences other than the mere composite age of the shareholders' accounts. For instance, the movement in prices has a quite noticeable effect on account closures, the tendency being for closure rates to increase when market prices are rising, as in the first nine months of 1929 when the gross closure in stockholder accounts rose to 15 per cent of the list. Compared with this experience, the gross loss for the



The Rate at Which Stockholders Close their Accounts Declines as the Years Pass and their Savings Become More Stabilized.

same months of 1933 was less than 10 per cent, in part because the list was then more largely composed of seasoned holders.

In turnover, the holdings of women are noticeably more stable than the holdings of men. In 1933, the closure in the accounts of men amounted to 16 per cent of the average number of men holding stock during the year, whereas the closure in the case of women stockholders was only a little over nine per cent. This fact of more rapid turnover in men holders explains in some measure why women holders now outnumber men by approximately 140,000, although their average holdings are less than those of men.

Because there is an inevitable "mortality" in stockholders, either the remaining holders must continuously stay in the market and increase their holdings or new investors must be attracted to the business. In either case it is necessary for the protection of stockholders and for the good of the System's credit that its securities should remain in healthy demand at all times, with willing purchasers available at reasonable prices. There is no other way to assure either the financial integrity of the business or an economically sound ratio between the amount of capital furnished by stockholders and funds loaned by bondholders. It is also essential that A. T. & T. stock, as the principal security of the System, should be held as an investment and not as a speculation. Speculative interests, whose first thoughts are for market profit, are transitory and incompatible with that long-range planning so important to an enterprise bound up with the public interest.

Regardless of its wishes in the matter, no company can prevent its stock from being subject to fluctuations in market prices under the impact of changes in the political or economic scene. While these changes in price may be disturbing to some investors, nevertheless they are a necessary consequence of a free security market. That there should be such a free market in A. T. & T. stock is almost axiomatic, since there is no person or group of persons with sufficient financial resources or foreknowledge of events who could determine where prices should be pegged. The Company feels that wide fluctuations in price are regrettable, but it feels more strongly that it should not attempt to influence or control the market, believing not only that it should not interfere, but also that an open market where all the various influences of investment opinion can have free play is the best kind of market place for stockholders to have when they desire to increase or decrease their holdings or to know how current events are affecting their investment interests.

The Bell System has striven for leadership in keeping stockholders and the public well-informed about its aims and operations; and it seeks to accomplish this result at minimum cost through regular quarterly and annual reports, through press releases and booklets descriptive of the business, and through advertisements and other recognized media for giving out information and attracting interest.

Just as the System believes that its business contacts with the public should be flexible and individual in character in order to provide the best service to telephone users, so also it seeks to maintain its contacts with stockholders on a warm personal basis. Correspondence and telephone calls from stockholders are welcomed and thoughtful attention is given to their individual inquiries. There is one question which stockholders sometimes ask that the Company cannot answer: it cannot attempt to advise about the future course of market prices or whether A. T. & T. stock should be bought or sold at any current level. Of course, stockholders are keenly interested in safeguarding their investment funds, and when they see reports or rumors in the newspapers concerning the telephone business, nothing is more natural than for them to turn to the Company for advice about the possible effect of the rumored developments on their shareholdings. In answer to such inquiries the Company can give pertinent facts about its business in the way of earnings, past results, and operating policies, but it cannot know enough of an individual's situation to give him special investment advice and, above all, it cannot foretell the future course of market prices.

It must be recognized that A. T. & T. stockholders are the equity owners of the Bell System and that it is they who are carrying the ultimate risks of the business. Continuously conscious of this fact, the Bell System has fortified the position of stockholders by every practical safeguard of conservative finance; it cheerfully follows the most rigorous rules of trusteeship; and by research and experimentation it is constantly improving the telephone art so that its service to the public may be the best and most modern that science can provide and at the lowest cost that will insure fair compensation to the employees and owners of the business. The best assurance that these million or more people have as to the future success of the Bell System lies in the record it has made to date for sound management and enlightened public service.

C. S. Van Cise

International Radio Telephone Circuits

IN an article in the BELL TELEPHONE QUARTERLY for July, 1930, entitled "World-Wide Telephony," reference was made to plans of the Bell System for the establishment of radio telephone facilities on the Pacific Coast through which service would be extended to the Hawaiian Islands, the Philippine Islands, and possibly to Australia and to countries of the Far East.

These facilities are now in operation and are being used to provide telephone service to the Hawaiian Islands, to the Island of Luzon in the Philippine group, and to Bandoeng, Java. There have also been established facilities near Miami, Florida, extending circuits to Central America, to some northerly situated South American countries, and to islands in the Caribbean. With the previously established stations on the Atlantic seaboard, the Bell System is now provided with stations on the three seaboards of the United States for overseas service by radio telephony, and it is thus in a position, without additional major expenditures, readily to extend its overseas services.

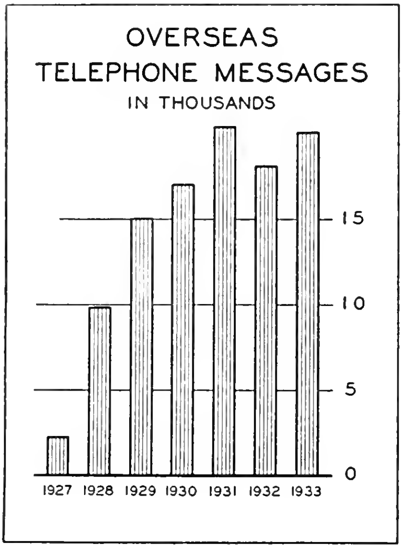
The radio facilities on the Pacific Coast were installed in 1931, the transmitter at Dixon and the corresponding receiver at Point Reyes, both in California. Provision is made for the co-ordinated operation of the transmitter and receiver at the long distance telephone office in San Francisco. In December of 1932, connection was established to the Hawaiian Islands, and in March, 1933, to the Island of Luzon in the Philippine group. In February of this year, a direct circuit was opened to Bandoeng, Java, and tests are now under way looking to the possible provision of a circuit to Japan. Negotiations are also under way for the establishment of a direct radio telephone circuit to Australia.

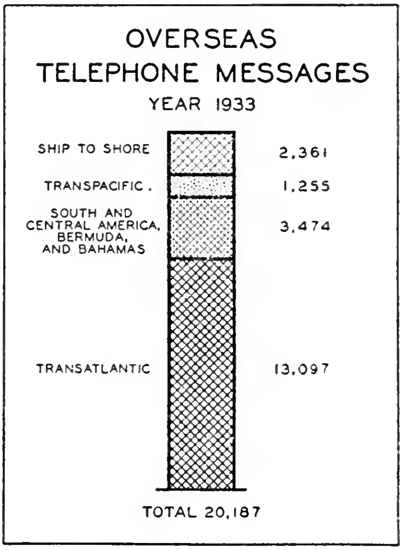
A radio telephone circuit to the Island of Bermuda was opened late in 1931, using the facilities at Lawrenceville and Netcong in New Jersey. The radio telephone terminals established near Miami, Florida, in 1932 have been used for connections to the Central American countries of Nicaragua, Costa Rica, Panama and Guatemala, to the northerly situated South American countries of Columbia and Venezuela, and to the Bahama Islands in the Caribbean.

At the beginning of this year, by means of the existing radio telephone facilities on the Atlantic and Pacific coasts and in Florida, together with the wire networks, any of the 16,600.000 telephones of the Bell System and its connecting companies may be connected with some 13,000,000 other telephones located in fifty countries and territories scattered over five continents. At present, 92 per cent of the world's telephones can be reached from any Bell System telephone.

The rest of the world has also been diligent in adding radio telephone circuits in the last three and one-half years. The map and list which follow this article show the existing and proposed international radio telephone circuits of the world at the beginning of the year 1934, amounting to 66 circuits in service, comprising about 250,000 circuit miles. The map included with the article of July, 1930, showed but 15 existing circuits with a total of little over 75,000 circuit miles. All of the circuits opened during recent years have utilized short waves.

On the Atlantic seaboard, ship-to-shore radio telephone service of the Bell System with ocean-going vessels has grown rapidly since its establishment in 1929. The transmitting and receiving stations for this service are at Ocean Gate and Forked River, New Jersey. Since December of 1929, when the service was opened with the Leviathan, it has been extended to 19 additional ships: Majestic, Olympic, Homeric, Empress of Britain, Europa, Hamburg, Rex, Conte di Savoia, Aquitania, Ile de France, Monarch of Bermuda, Queen of Bermuda, Deutschland, Bremen, Albert Ballin, New York, Columbus, Caledonia and Berengaria.

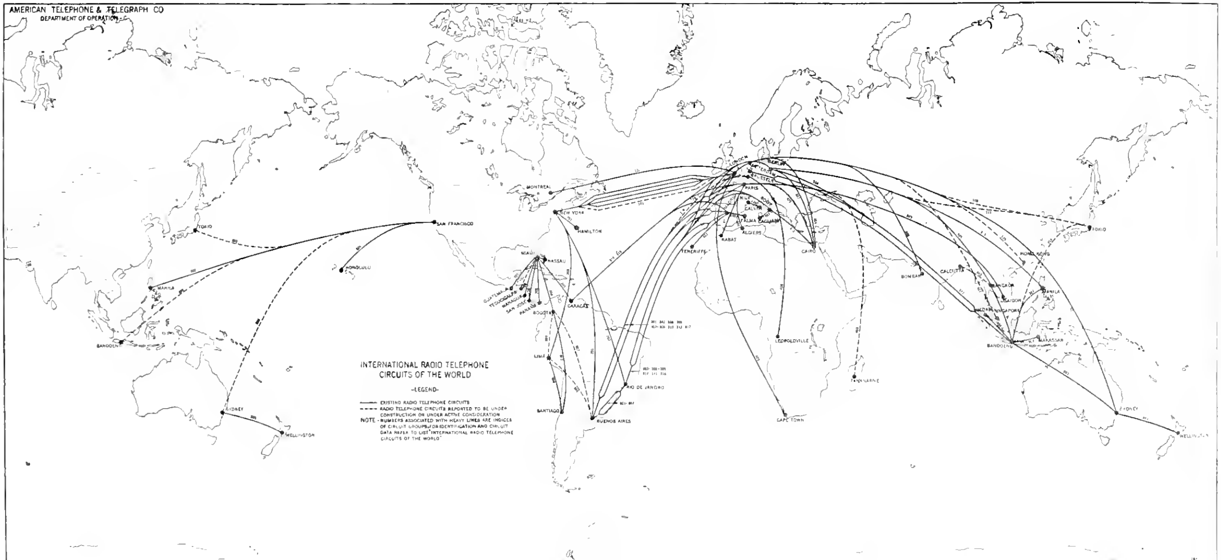




THESE TWO CHARTS SHOW THE OVERSEAS TELEPHONE MESSAGES HANDLED THROUGH THE TRANSMITTING AND RECEIVING STATIONS OF THE AMERICAN TELEPHONE AND TELEGRAPH COMPANY.

The overseas telephone messages of the Bell System are shown graphically in the accompanying charts taken from the Annual Report of the American Telephone and Telegraph Company for the year 1933.

ELAM MILLER



Map Showing the International Radio Telephone Circuits of the World as of January 1, 1934. A Tabulation of These Circuits Begins on the Opposite Page.

International Radio Telephone Circuits of the World as of January 1, 1934

Circuit Group	Circuit Terminals	Ownership	Statute Miles	Service Date
	North America–Europe Existing Circuits			
101	(1) †New York– †London (Long Wave)	American Tel. and Tel. Co. British Post Office	3,448	1/ 7/27
	(2) †New York– †London	American Tel. and Tel. Co. British Post Office	3,448	6/ 6/28
	(3) †New York– London	American Tel. and Tel. Co. British Post Office	3,448	6/ 1/29
	(4) †New York– †London	American Tel. and Tel. Co. British Post Office	3,448	12/ 1/29
102	†Montreal– London	Canadian Marconi Ltd. British Post Office	3,245	7/11/32
	Proposed Circuit			
101	(5) †New York– †London	American Tel. and Tel. Co. British Post Office	3,448	
	No. America–So. America Existing Circuits			
201	New York– †Buenos Aires	American Tel. and Tel. Co. Compania Int. de Radio*	5,327	4/ 3/30
202	New York– Rio de Janeiro	American Tel. and Tel. Co. Co. Radio Int. do Brasil*	4,849	12/18/31
203	New York– Lima	American Tel. and Tel. Co. Co. Peruana de Tel. Ltd.*	3,679	10/14/32
204	Miami– †Bogota	American Tel. and Tel. Co. Co. Telefonica Central	1,514	12/22/32
205	Miami– Caracas	American Tel. and Tel. Co. Co. Ann. Nac. Tel. de Ven.	1,362	12/19/32
	Europe–South America Existing Circuits			
301	London– Buenos Aires	British Post Office Compania Int. de Radio*	6,921	12/12/30
302	London– Buenos Aires	British Post Office Transradio Internacional	6,921	12/12/30
303	London– Rio de Janeiro	British Post Office Companhia R.T. Brasileira	5,769	5/21/31
304	Paris– Buenos Aires	Companie Generale de T.S.F. Compania Int. de Radio*	6,868	6/11/30
305	Paris– Buenos Aires	Companie Generale de T.S.F. Transradio Internacional	6,868	2/ 1/29
306	Paris– Rio de Janeiro	Companie Generale de T.S.F. Companhia R.T. Brasileira	5,695	3/31/30
307	Berlin– Buenos Aires	German Post Office Compania Int. de Radio*	7,406	9/10/30
308	Berlin– Buenos Aires	German Post Office Transradio Internacional	7,406	12/10/28

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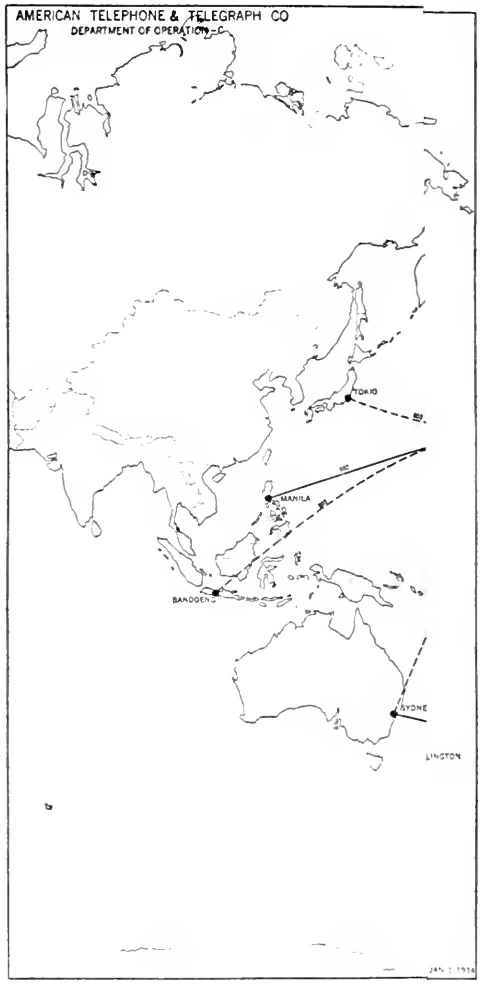

Map Showing the I

International Radio Telephone Circuits of the World as of January 1, 1934

Circuit Group	Circuit Terminals	Ownership	Statute Miles	Service Date
	North America–Europe Existing Circuits			
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	(2) †New York– †London	American Tel. and Tel. Co. British Post Office	3,448	6/ 6/28
	(3) †New York– London	American Tel. and Tel. Co. British Post Office	3,448	6/ 1/29
	(4) †New York– †London	American Tel. and Tel. Co. British Post Office	3,448	12/ 1/29
102	†Montreal– London	Canadian Marconi Ltd. British Post Office	3,245	7/11/32
	Proposed Circuit			
101	(5) †New York– †London	American Tel. and Tel. Co. British Post Office	3,448	
	No. America–So. America Existing Circuits			
201	New York– †Buenos Aires	American Tel. and Tel. Co. Compania Int. de Radio*	5,327	4/ 3/30
202	New York– Rio de Janeiro	American Tel. and Tel. Co. Co. Radio Int. do Brasil*	4,849	12/18/31
203	New York– Lima	American Tel. and Tel. Co. Co. Peruana de Tel. Ltd.*	3,679	10/14/32
204	Miami– †Bogota	American Tel. and Tel. Co. Co. Telefonica Central	1,514	12/22/32
205	Miami– Caracas	American Tel. and Tel. Co. Co. Ann. Nac. Tel. de Ven.	1,362	12/19/32
	Europe–South America Existing Circuits			
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305	Paris– Buenos Aires	Companie Generale de T.S.F. Transradio Internacional	6,868	2/ 1/29
306	Paris– Rio de Janeiro	Companie Generale de T.S.F. Companhia R.T. Brasileira	5,695	3/31/30
307	Berlin– Buenos Aires	German Post Office Compania Int. de Radio*	7,406	9/10/30
308	Berlin– Buenos Aires	German Post Office Transradio Internacional	7,406	12/10/28

INTERNATIONAL RADIO TELEPHONE CIRCUITS OF THE WORLD AS OF JANUARY 1, 1934
(*Continued*)

Circuit Group	Circuit Terminals	Ownership	Statute Miles	Service Date
	Europe–South America Existing Circuits (Cont'd)			
309	Berlin– Rio de Janeiro	German Post Office Companhia R.T. Brasileira	6,230	3/21/30
310	Berlin– Caracas	German Post Office Co. Ann. Nac. Tel. de Ven.	5,150	9/13/31
311	Madrid– Buenos Aires	Co. Tel. Nac. de Espana* Compania Int. de Radio*	6,248	10/12/29
312	Madrid– Buenos Aires	Compania Transradio Espanola Transradio Internacional	6,248	/ /29
314	Madrid– Rio de Janeiro	Compania Transradio Espanola Companhia R.T. Brasileira	5,057	/ /30
315	Madrid– Rio de Janeiro	Co. Tel. Nac. de Espana* Co. Radio Int. do Brasil*	5,057	1/28/32
317	Rome– Buenos Aires	Italo Radio Transradio Internacional	6,930	12/ 1/31
318	Rome– Rio de Janeiro	Italo Radio Companhia R.T. Brasileira	5,713	10/28/31
319	Madrid– Caracas	Co. Tel. Nac. de Espana* Co. Ann. Nac. Tel. de Ven.	4,355	12/19/32
320	Paris– Caracas	Companie Generale de T.S.F. Co. Ann. Nac. Tel. de Ven.	4,740	7/24/33
	Proposed Circuit			
316	Brussels– Buenos Aires	Belgium Government Transradio Internacional	7,028	
	Europe–Africa Existing Circuits			
401	Paris– †Rabat	Companie Generale de T.S.F. Moroccan T. and T. Admin.	1,132	11/ 3/30
402	Madrid– †Teneriffe	Co. Tel. Nac. de Espana* Co. Tel. Nac. de Espana*	1,128	1/22/31
403	London– †Capetown	British Post Office Overseas Com. Co. of S.A.	6,011	2/ 1/32
404	London– Cairo	British Post Office Marconi R.T. of Egypt	2,179	6/22/32
405	†Paris– †Algiers	French P.T.T. French P.T.T.	836	6/ 6/33
406	†Brussels– †Leopoldville	Belgium Government Belgium Government	3,893	9/15/32
407	Berlin– Cairo	German Post Office Marconi R.T. of Egypt	1,808	7/22/32
409	Paris– Cairo	Companie Generale de T.S.F. Marconi R.T. of Egypt	1,993	11/ 1/32
410	Rome– Cairo	Italo Radio Marconi R.T. of Egypt	1,328	12/20/32

International Radio Telephone Circuits of the World as of January 1, 1934
(*Continued*)

Circuit Group	Circuit Terminals	Ownership	Statute Miles	Service Date
	Europe–Africa Proposed Circuit			
408	Paris– Tananarive	French P.T.T. French P.T.T.	5,488	
	Europe–Asia–Oceania Existing Circuits			
501	London– Sydney	British Post Office Amal. Wireless Australasia	10,557	4/30/30
502	(1) †Amsterdam– Bandoeng	Netherlands Government Neth. Indies Tel. Admin.	7,294	1/ 8/29
	(2) †Amsterdam– Bandoeng	Netherlands Government Neth. Indies Tel. Admin.	7,294	12/ 1/29
503	Paris– †Saigon	Compagnie Generale de T.S.F. Compagnie Generale de T.S.F.	6,298	4/11/30
504	Berlin– Bandoeng	German Post Office Neth. Indies Tel. Admin.	6,726	12/27/29
505	Berlin– Bankok	German Post Office Siamese Government	5,349	4/15/31
506	London– †Bombay	British Post Office Indian R.T. Co.	4,545	5/ 1/33
510	Berlin– Manila	German Post Office Phil. L.D. Telephone Co.	6,124	3/ 1/33
	Proposed Circuits			
507	London– Singapore	British Post Office Imp. and Int. Comm. Ltd.	7,694	
508	London– Tokio	British Post Office Japanese Government	5,941	
509	London– Hong Kong	British Post Office Hong Kong Tel. Co.	5,979	
511	Berlin– Tokio	German Post Office Japanese Government	5,532	
	No. America–Asia–Oceania Existing Circuits			
601	San Francisco– †Honolulu	American Tel. and Tel. Co. Mutual Telephone Co.	2,393	12/23/31
602	San Francisco– Manila	American Tel. and Tel. Co. Phil. L.D. Telephone Co.	6,969	3/30/33
	Proposed Circuits			
603	San Francisco– Tokio	American Tel. and Tel. Co. Japanese Government	5,133	
604	San Francisco– Sydney	American Tel. and Tel. Co. Australian Post Office	7,425	

INTERNATIONAL RADIO TELEPHONE CIRCUITS OF THE WORLD AS OF JANUARY 1, 1934
(*Continued*)

Circuit Group	Circuit Terminals	Ownership	Statute Miles	Service Date
	No. America–Asia–Oceania Proposed Ciccuits (Cont'd)			
605	San Francisco– Bandoeng	American Tel. and Tel. Co. Neth. Indies Tel. Admin.	9,101	
	North America Existing Circuits			
701	†New York– †Hamilton (Bermuda)	American Tel. and Tel. Co. Imp. and Int. Comm. Ltd.	795	12/21/31
703	Miami– †Managua (Nicaragua)	American Tel. and Tel. Co. Tropical R.T. Co.	1,002	6/ 7/33
704	Miami– †San Jose (Costa Rica)	American Tel. and Tel. Co. Tropical R.T. Co.	1,120	3/20/33
705	Miami– †Panama	American Tel. and Tel. Co. Tropical R.T. Co.	1,161	2/24/33
706	†Miami– †Nassau	American Tel. and Tel. Co. Bahamas Government	175	12/16/32
707	Miami– †Guatemala	American Tel. and Tel. Co. Tropical R.T. Co.	1,017	4/17/33
	Proposed Circuit			
702	Miami– †Tegucigalpa (Honduras)	American Tel. and Tel. Co. Tropical R.T. Co.	919	
	South America Existing Circuits			
801	Buenos Aires– Rio de Janeiro	Transradio Internacional Companhia R.T. Brasileira	1,227	/ /31
802	Buenos Aires– Rio de Janeiro	Compania Int. de Radio* Co. Radio Int. do Brasil*	1,227	12/12/31
803	†Bogota– Santiago	All American Cables, Inc.* Co. Int. de Radio S.A.*	2,644	8/ 1/31
804	Lima– Santiago	Co. Peruana de Tel. Ltd.* Co. Int. de Radio S.A.*	1,537	12/15/32
	Proposed Circuits			
805	Lima– Bogota	Co. Peruana de Tel. Ltd.* All American Cables, Inc.*	1,166	
806	Lima– Buenos Aires	Co. Peruana de Tel. Ltd.* Compania Int. de Radio*	1,952	
807	Bogota– Buenos Aires	All American Cables, Inc.* Compania Int. de Radio*	2,902	
	Asia–Oceania Existing Circuits			
901	Sydney– Wellington	Australian Post Office New Zealand Government	1,375	11/25/30

International Radio Telephone Circuits of the World as of January 1, 1934
(*Continued*)

Circuit Group	Circuit Terminals	Ownership	Statute Miles	Service Date
	Asia–Oceania			
	Existing Circuits (Cont'd)			
902	Bandoeng–	Neth. Indies Tel. Admin.		
	Bankok	Siamese Government	1,469	4/15/31
903	Bandoeng–	Neth. Indies Tel. Admin.		
	Sydney	Australian Post Office	3,392	12/23/30
904	Bandoeng–	Neth. Indies Tel. Admin.		
	†Medan (Sumatra)	Neth. Indies Tel. Admin.	875	9/16/31
906	Bandoeng–	Neth. Indies Tel. Admin.		
	†Makassar (Celebes)	Neth. Indies Tel. Admin.	854	7/ 1/33
907	Bandoeng–	Neth. Indies Tel. Admin.		
	Manila	Phil. L.D. Telephone Co.	1,742	2/23/33
	Proposed Circuits			
905	Bankok–	Siamese Government		
	Calcutta	Indian Radio Company	1,008	
908	Bandoeng–	Neth. Indies Tel. Admin.		
	Tokio	Japanese Government	3,609	
	Europe			
	Existing Circuits			
1001	Madrid–	Co. Tel. Nac. de Espana*		
	†Palma (Majorca)	Co. Tel. Nac. de Espana*	330	10/24/31
1002	†Nice–	French P.T.T.		
	†Calvi (Corsica)	French P.T.T.	105	6/ 1/32
1003	Rome–	Azienda di Stato Ser. Tel.		
	Cagliari (Sardinia)	Azienda di Stato Ser. Tel.	257	/ /32

* Indicates International Tel. and Tel. Co. subsidiary or affiliate.
† Indicates terminal does not share time with other circuits.

Notes on Recent Occurrences

DIRECT RADIO TELEPHONE CIRCUIT LINKS UNITED STATES AND JAVA

A DIRECT radio telephone circuit between San Francisco and Java, in the Dutch East Indies, was opened on February 1. Service over the new channel is available to all Bell and Bell-connecting telephones in the United States, Canada, Cuba and Mexico, and at the other end it reaches not only Java but Sumatra.

Prior to the opening of the new circuit, telephone communication between the United States and the Dutch East Indies was maintained by way of New York, London and Amsterdam. From the west coast of the United States the total length of the older circuit was 14,500 miles, made up of two radio channels and 3,600 miles of land lines. The length of the new channel is 8,700 miles. It is the longest radio circuit operated by the American Telephone and Telegraph Company, being twice as long as those between New York and London and over 1,700 miles longer than the circuit now in service between San Francisco and Manila.

The new service is maintained through the short wave radio telephone stations of the American Telephone and Telegraph Company in California, which for some time have handled the service to Hawaii and the Philippines. The transmitting station is at Dixon, near Sacramento, and the receiving station at Point Reyes, just north of San Francisco.

The cost of a call between Java and any point on the Pacific coast is $30 for the first three minutes and $10 for each additional minute. To other points in the United States, Canada, Cuba and Mexico the rates are proportionately higher.

DR. JEWETT ELECTED A TRUSTEE OF CARNEGIE INSTITUTION

DR. FRANK B. JEWETT, vice president of the American Telephone and Telegraph Company and president of the Bell Telephone Laboratories, was elected a member of the Board of Trustees of the Carnegie Institution of Washington on December 15, 1933.

"SIGNALS AND SPEECH IN ELECTRICAL COMMUNICATION"

FROM the pen of John Mills, member of the technical staff of Bell Telephone Laboratories, has come a book designed for readers who would like a clear non-technical introduction to the mysteries and complexities of electrical communication. Under the title "Signals and Speech in Electrical Communication," the book presents the philosophy of the electrical transmission of intelligence, the general principles for communication by wire and by radio.

Sixteen short chapters, written in a semi-technical manner and free from mathematics and diagrams, present readable and interesting explanations of dial switching, telephone repeaters, multi-channel transmission systems and transoceanic communication. The engineering achievements in the allied fields of sound pictures, broadcasting, television and stereophonic reproduction are also explained.

In the chapter entitled "The Vivisection of Speech" are explained the complexities of human speech, and the method of "scrambling" speech which is undertaken for privacy in radiotelephone conversation. Under the title "The First War with Attenuation" the author traces the romantic history of transcontinental telephony, and in "The Modern Jinn" he describes how the electrons in a vacuum tube play their part in the marvels of telephony. The chapter on "The Natural Limits" tells the limitation which nature imposes upon the efforts of communication engineers. The chapter which deals with dial telephone switching, "Communication with Electrical Brains," appeared as a separate article in the January issue of the BELL TELEPHONE QUARTERLY while the book was on the press of Harcourt, Brace and Company, its publishers.

BELL TELEPHONE QUARTERLY

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MEETING AN EMERGENCY AT BIRMINGHAM, ALABAMA

CONFERENCE TELEPHONE SERVICE

WORLD'S TELEPHONE STATISTICS

ADVENTURES IN COMMUNICATION

ERICAN TELEPHONE & TELEGRAPH CO. • NEW YORK

BELL TELEPHONE QUARTERLY

A Medium of Suggestion and a Record of Progress

CONTENTS FOR JULY 1934

PAGE

Meeting an Emergency at Birmingham, Alabama—*F. M. Craft* 155

Conference Telephone Service—*Helene C. Bateman* 176

World's Telephone Statistics—*C. J. Koukol* 188

Adventures in Communication—*J. O. Perrine* 200

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INFORMATION DEPARTMENT
AMERICAN TELEPHONE AND TELEGRAPH COMPANY
195 Broadway, New York

CONTRIBUTORS TO THIS ISSUE

F. M. CRAFT

Ohio State University, M.E. in Electrical Engineering, 1905. Western Electric Company, Engineering Department, Chicago, 1905–1916. Chesapeake and Potomac Telephone Company, Baltimore, Supervisor of Central Office Engineering, 1916–1917; Resident Engineer, District of Columbia, 1917–1919; Baltimore, Engineer of Machine Switching Equipment, 1919–1920; Equipment Engineer, 1920–1921. Northwestern Bell Telephone Company, Equipment and Building Engineer, 1921–1923. Ohio Bell Telephone Company, Building and Equipment Engineer, 1923–1925. Southern Bell Telephone and Telegraph Company, Chief Engineer, 1925–.

HELENE C. BATEMAN

Barnard College, Columbia University, B.A., 1917. American Telephone and Telegraph Company, Commercial Engineer's Division, 1917–.

C. J. KOUKOL

Columbian University, E.E., 1914. American Telephone and Telegraph Company, Department of Development and Research, 1914–1921; Chief Statistician's Division, 1921–.

J. O. PERRINE

University of Iowa, B.A., 1909; University of Michigan, M.S., 1915; Cornell University, Ph.D., 1921. American Telephone and Telegraph Company, Department of Development and Research, 1921–1925; Information Department, 1925–. Now Associate Editor, *Bell System Technical Journal.*

Meeting an Emergency at Birmingham, Alabama

Editor's Note:

In the April, 1934, issue of the BELL TELEPHONE QUARTERLY, the Chief Engineer of the Indiana Bell Telephone Company described the co-operative efforts that restored telephone service in record-breaking time after a destructive fire at Anderson, Indiana. In the following article, the Chief Engineer of the Southern Bell Telephone and Telegraph Company graphically recounts similar efforts in meeting the emergency caused by a fire at Birmingham, Alabama, on March 10, and gives a picture of the telephone problem involved that reveals the complexities of telephone service in a large city as well as the traditional spirit of Bell System people.

THE lull of a Saturday noon in Birmingham, Alabama, was disturbed by an alarm of fire, and a smudge of smoke at the front corner of one of the city's largest department stores was the center of concentration of the downtown fire companies responding to a routine alarm. Hours later, when the hose was finally rolled up by exhausted, red-eyed firemen, Birmingham had experienced its worst fire and March 10, 1934, had become a day of tragedy long to be remembered. Buildings in an area of half a block had been consumed or seriously damaged and the fate of the downtown district had hung in the balance while a March wind whipped hundred-foot flames over the surrounding buildings and carried burning embers over a wide area. Heroic effort finally prevailed, and the city rested easy late that night with the fire finally controlled.

Large fires can have small beginnings, and the trace of smoke which trickled up from under the first floor of the Loveman, Joseph & Loeb department store shortly after 12:30 gave little indication that more than a fire extinguisher would be needed to combat it. No one's imagination could foresee that within a few short hours all available fire apparatus in Birmingham and the surrounding cities would be fighting to save the city from the results of so small a blaze, the hospitals would be receiving injured firemen, and a large area of the city would be without telephone service.

Telephone service for Birmingham was provided from six central office locations. The downtown area has two central office buildings: Main, which was damaged by the fire, is located on Second Avenue and housed local manual office No. 4, the toll switchboard for the city, and special services such as information and assistance operators; while the new building, a half-dozen blocks away on Sixth Avenue, contains the toll terminal and line repeater equipment, together with two step-by-step dial offices, designated No. 3 and No. 7. Three of the remaining buildings house dial offices, while the fourth serves a small outlying community on a manual basis. Traffic to and from the nearby town of Bessemer is handled on an A–B toll basis, with the dial service operators ticketing calls outgoing from the Birmingham dial offices.

Fire Under the Store's Ground Floor

The Loveman, Joseph & Loeb department store covered one-fourth of a block, as shown by Figure 1, which indicates the damaged area with respect to the telephone building. The clerks were waiting on several thousand customers who had responded to a well-advertised sale. Steel mill operations around Birmingham had picked up, coal mining had increased due to abnormally cold weather, and business was good. When smoke was seen and an alarm turned in, the management, in the exercise of conservative good judgment, proceeded to clear the store of all clerks and customers. Good feeling prevailed and everyone moved out casually for the few minutes needed for the firemen to handle a seemingly small job.

The four fire companies which normally respond to downtown alarms came up within a few minutes and proceeded toward the heart of the smoke. The store had a relatively small basement, in which the building services were located. The remainder of the first floor was from three to six feet above ground, with the floor supported on brick partitions which divided the area longitudinally into a number of restricted sections, each about 10 feet wide. The fire was located in one of these sections, which firemen found full of suffocating smoke, preventing direct entry. There was no sprinkler equipment in this space.

Recognizing that the first requirement of fighting a fire is to get at it, squads of firemen started cutting through the wooden

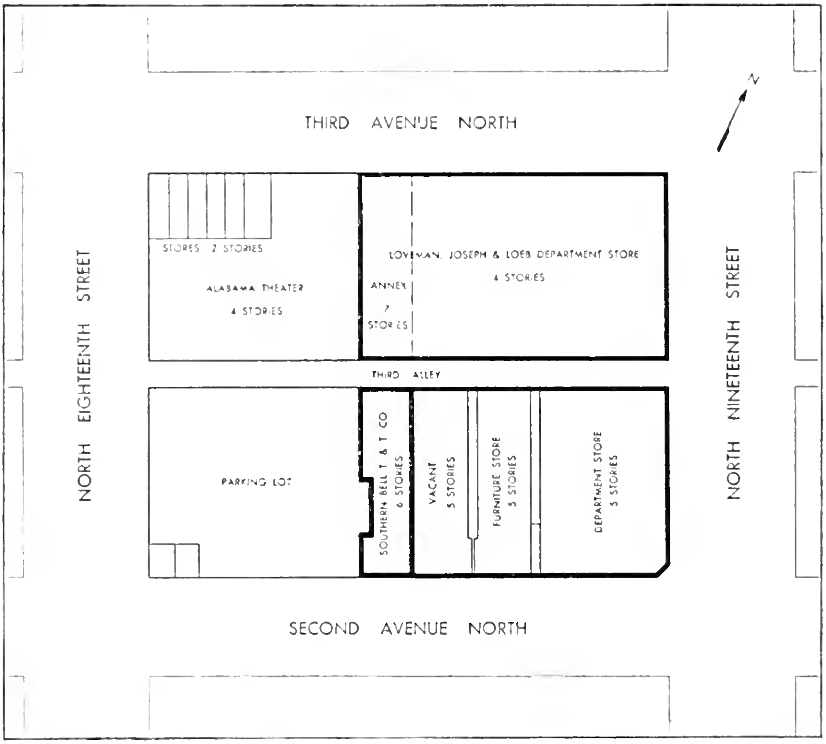


FIG. 1. RELATION OF THE MAIN TELEPHONE BUILDING TO THE ORIGIN OF THE FIRE. DAMAGED OR DESTROYED BUILDINGS ARE INDICATED BY HEAVY LINES

flooring of the first floor. By the time this was completed, a considerable blaze was burning in the area. Water introduced through these holes caused a reduction in the volume of smoke, and the firemen as well as the spectators thought the fight had been won.

This view was held but shortly, for an increased volume of smoke disclosed that the fire had spread over a much larger area than had been anticipated and other sections under the first floor were burning. A second alarm brought up a number of additional fire companies and they continued the work of cutting through the floor at other points. The basement partitions greatly impeded the firemen, since each section presented a separate problem to be worked out while the fire spread rapidly from one to the other along the floor joists.

Smoke became unbearable to the firemen, and even relief every few minutes was not sufficient to permit operations to be continued from inside the building. The men were forced to withdraw and rely on flooding the first floor. A large quantity of smoke was then pouring from the building, but no flame was seen by the spectators until nearly 3:30 P.M.

The Building Was Doomed

Inflammable gases from the smouldering fire under the first floor went up the elevator shaft and stairs, and accumulated in the upper stories. With the first show of fire, the top three floors burst into flame with almost explosive violence. Upon this occurrence, no doubt remained that the building was doomed and a general alarm brought up the remaining fire crews with the exception of necessary reserve companies. Effort was then concentrated toward preventing the spread of flames to other structures. This was effective with the exception of those buildings directly across Third Alley from Loveman's, the majority of which were seriously damaged. Among the latter was the Main telephone building.

Part of the department store comprised a six-story reinforced concrete annex, which was directly to the rear of the telephone building and had openings on various floors into the main store building. This structure, being fire-resistive, fortunately offered a measure of protection to the telephone building.

Shortly after the fire started, the Alabama Plant Superintendent, together with other plant and traffic supervisory people, promptly proceeded to the telephone building, to be present in the event any emergency should arise, remote as it seemed at that time. The fire, however, gave them little concern until after 1:30, when heavy clouds of smoke began pouring across Third Alley from Loveman's main building and annex, a stiff wind driving the smoke into the rear of the telephone building.

As soon as a possibility appeared that the fire might get out of control, vigorous measures were started toward protecting the service and saving the building and equipment. Maintenance of service as long as possible was an immediate concern, and all windows and doors at the rear of the building were latched and cracks around them caulked. Exhaust fans at the rear of each floor were operated to create a through draft from the relatively clearer air on Second Avenue at the front of the building. This gave a measure of relief to the operators on duty and those off for the afternoon who came without call with the knowledge that they would be needed to cope with the heavy traffic created by the emergency. The critical time which all telephone people dread, of discontinuing service from an office, was postponed.

Steps Taken to Protect the Equipment

Plant men and other employees off duty reported to the building, to assist with steps to protect the service and property. One squad manned the house fire line and saturated the roof in the face of blinding and suffocating smoke. All of the company's tarpaulins in the city were assembled at the building. Packing quilts and tarpaulins were secured from transfer companies and squads were assigned to cover the various equipment units for protection against possible water damage. Particularly noteworthy was the attention given to the main frame, since trunks between other offices passed through it and its loss would greatly complicate restoration if necessity arose for transferring the service to another location. This work was successful, and despite a great quantity of water later poured into the upper portion of the building, the main frame remained undamaged.

The operators stuck grimly to their switchboards, for the growing fire was bringing a flood of telephone calls. It was children's day at the Alabama Theater, which adjoins the Loveman annex, and anxious mothers who heard the radio reports on the fire were calling to inquire about their children. Messages for doctors, ambulances, hospitals, piled in to add to the task. Long distance calls for help were made to cities in Alabama and Georgia—as far away as Atlanta—where fire-fighting equipment was dispatched or held in readiness.

Building Finally Had to Be Vacated

By this time great billows of smoke were rolling upward in black clouds from Loveman's, while flames leaped high into the air. Operators and plant employees could hear the roar of flames across the alley. Operators were working in relays of twenty minutes, and wet towels were given them to afford some relief to their smarting eyes as the smoke became more dense. The girls worked quietly and efficiently, although they could hardly see the switchboard markings. Plant men were stationed on each operating floor to assist them.

The Plant Superintendent was outside, for the purpose of giving the alarm should occupancy of the building become hazardous, and watched the hopeless battle of the firemen. The flames mounted in Loveman's main building and annex, whence the high March winds carried them across the twenty-foot alley against the buildings along Second Avenue.

At 3:30 the order was given to vacate the building, since the smoke and heat made longer occupancy impossible. The girls quietly arose from their positions and walked calmly to the street. No one ran and no one seemed excited; the same calm efficiency with which they handled the traffic marked their conduct at all times. Quarters were arranged for the operators in a nearby hotel, so that the switchboard could be operated again promptly if the equipment escaped damage.

Some 8300 telephones were now without service. For a few, but very few, minutes Birmingham was isolated from telephone communication with the outside world. Soon after the toll switchboard was abandoned, however, operators were working in strange surroundings, operating the toll test board in the Sixth Avenue building to handle emergency calls.

Shortly after service was suspended in the Main building, discovery was made that the space between the ceiling of the sixth floor and the roof had ignited. The fire department responded and went into this attic space with three lines of hose. Smoke was thick in this restricted area and a number of firemen were overcome. Plant men who remained in the building to help carried out six of them to a first aid station set up by the American Red Cross in a nearby store. One of their own number was also overcome by smoke and had to be sent to the hospital.

Tons of Water Did the Damage

The telephone people watched with mixed emotions the immense quantity of water, usually their worst enemy, being poured into the building to save it from destruction by an even more dangerous one, knowing that telephone equipment which has been wet might almost as well have been burned. Despite the countless tons of water which went into this attic space, practically all but the largest roof timbers in the rear were destroyed and the ceiling gave way in several places on the sixth floor.

This was substantially all the fire damage. Wire glass doors and windows in the rear were cracked, but none gave way. Two ventilating fans were burned from their mountings, but the building did not catch fire from these openings. No equipment was hurt by fire, but upon the havoc wrought by water hangs the remainder of this narrative.

The General Office in Atlanta was notified promptly of the discontinuance of service, and by four o'clock the attic fire clearly indicated that substantial damage would be done to the equipment. Headquarters plant, traffic and engineering people needed were promptly assembled and plans made for the restoration of service on an emergency basis. Fortunately, there were two telephone buildings in downtown Birmingham, as noted above. Plans were formulated for the use of the new building when the probability arose that the equipment would have to be replaced.

The two dial units in this building had such margins, due to recession of station development, that sufficient line and switch capacity was available for the transfer of practically all lines served by the No. 4 Office. Comparative studies made some time ago had shown that the downtown area should ultimately be served from one center. It was obvious, therefore, that the proper method of emergency restoration was the employment of these available dial lines, with the thought that in the event the damage to the equipment proved to be as extensive as was at first apparent, the transfer could be made permanent.

Equipment Starts Rolling In

Provision of toll and special services presented a somewhat more difficult problem, and, various plans having been considered, decision was made to set up a temporary office in the assembly room of the Sixth Avenue building by modifying No. 550 private branch exchange sections, a quantity of which were available in Birmingham and at the Atlanta warehouse of the Western Electric Company. Movement toward Birmingham of these, together with switchboard cable, frame wire, dials, and station equipment was started at once, several trucks leaving Atlanta that night. The General Office Committee, having determined the basic plan of procedure, left Atlanta on the midnight train, arriving in Birmingham early Sunday morning.

By the time they arrived, the local forces had transferred all

PBX battery and ringing current feeders in the old office to the No. 3 and No. 7 building. Temporary trunks from each of these switchboards and all municipal, fire department, hospital, and doctors' residence telephones were connected to the dial office. Provision was thus made for public safety and imperative necessities.

Inspection of the old building and equipment found them to be saturated with water dripping from ceilings and still running down walls on all floors. Bowl type electric lighting fixtures as far down as the second floor were filled with water. Water in the walls formed blisters behind the paint even on the lower floors, and these still remained two months after the fire. Notwithstanding the efforts made to cover the equipment, water was standing in many switchboard sections and the cable runs were dripping wet. While the power switches were opened, current was fed into the equipment over the trunk circuits from other offices, which caused an electrolytic action to be set up resulting in the development of a foamy excrescence around certain of the terminal strips and on some of the cable runs. Relays and connecting blocks were green with corrosion. Efforts to dry out the switchboards, cable runs, and relays by application of heat and operation of fans were of no avail. The majority of the equipment clearly had seen its last service and it was evident that the transfer of lines to the dial office should be permanent.

Manpower Is Available When Needed

With the fact of permanency established, the problem of restoring service to the flat-rate telephones became largely a matter of cross-connecting lines on the old main frame from the subscribers' cables to available pairs in trunk cables to the dial office, and providing dials on the station equipment. Fourteen installers and six frame men were transferred to Birmingham from Nashville, Chattanooga, Memphis, and New Orleans to facilitate this work.

The assembly room in the Sixth Avenue building presented a spectacle of vigorous but orderly work. Plant men and Western Electric installers who had arrived in response to emergency calls were setting up the switchboard sections in three lines as they arrived by truck and express. The Outside Plant forces had run cables along the outside of the building and through windows, connecting a temporary distributing frame in the assembly room with the toll testroom on the third floor and the dial main distributing frame on the first floor. Battery and ringing current supply had been provided with twisted pairs from the power room.

PBX Circuits Modified

The No. 550 PBX was never intended to be used as a toll switchboard, having been designed to handle inter-communicating calls within a business house and calls to and from local dial or manual central offices. In the service in which the emergency placed this equipment, line terminals were connected to trunks from the dial offices, on the one hand, and, on the other, to toll lines through the intervening toll test board, carrier terminals, and repeaters. The relays and equipment at one end of a telephone circuit must be proper to function with those at the other. Signal lamps must be lighted to indicate incoming calls and extinguished when answered; dial switches must be operated by the switchboard dials, held until the conversation is completed, and released; and above all, conversations passing through the switchboard must be clear and without interruption. These problems, and countless others of a similar nature, necessitated the designing of the proper circuits for the PBX to operate with the circuits already installed in the dial offices and the toll terminal room. The problem was, in brief, somewhat similar to that of introducing a strange wheel into an old watch: much modifying had to be done.

Circuit design is normally a contemplative work, calling for studious concentration and, for best results, a relatively clois-

The Loveman, Joseph & Loeb Building Fire Shortly After 3:30 P.M

The Temporary Toll Office in the New Downtown Building in Birmingham, Alabama tered seclusion. In this instance, uninterrupted concentration was a luxury denied under the pressure of arriving materials, installers looking for instructions as to procedure and, to cap all, an inexorable clock placing the minutes back of it until service should be restored. The job was there and traditional requirements fell. Circuits were developed on drawing boards, and from these pencil drawings equipment quantities were estimated, relays, keys and other items were ordered by telephone and immediately started moving toward Birmingham. When they arrived, wiring diagrams were ready and the installers, working almost shoulder to shoulder, placed the equipment in service. Despite the pressure, in no significant way was it necessary to change the circuits proposed, and each step toward the final result was an orderly procedure from the ground work of the previous one.

Long Distance Operation Under Difficulties

Birmingham is the most important long distance point in Alabama, and toll circuits converge thickly upon it from surrounding cities and towns. In all, 185 of these circuits were terminated on the toll switchboard, and the loss of this switchboard resulted in the loss to these towns of their principal, and in many cases only, outlet to the Bell System network. One of the first steps of service restoration was the establishing of an emergency toll circuit layout whereby terminal circuits at Birmingham were connected to give through connections. For example, an Atlanta-Birmingham circuit was connected with a Birmingham-Tuscaloosa circuit, resulting in a direct channel between Tuscaloosa and Atlanta, and consequently to the rest of the telephone world. This arrangement increased the need for circuits, and two carrier telephone systems which had been removed from service were reconnected. Thirty-four such inter-connections were made during Saturday night before the fire was extinguished, and later four more circuits were set up.

The operators who reported at the toll test room found a strange switchboard. Nothing was familiar. Even the cords had two plugs on each end. Six operators took positions at the toll testboard and two at the telegraph board, to do the best they could with what they had. The American Telephone and Telegraph Company's test room force gave enthusiastic co-operation with that of the Southern Bell Company in instructing the operators and assisting them.

The testboard has no telephone signalling facilities for incoming calls, although the distant toll switchboards can be rung from it on outgoing calls. The emergency arrangement for traffic from cities where a large group of circuits was available, such as Atlanta, was to assign one circuit in each group for dispatching, with an operator at each end constantly connected to it. These operators would assign other circuits in the group to the regular toll operators as they were needed for messages. Telegraph test wires which run to other of the more important toll points were used for signalling on emergency calls. A Chicago operator with such a call, for example, would notify the testroom force there and they would use the test line to Birmingham to have the operator pick up the Chicago toll line which was being held. The Birmingham operator would then complete the call over emergency dial trunks which had been promptly installed, provided, of course, it was not for an Office 4 number. Distant exchanges without test wires were called frequently to see if they had Birmingham calls waiting. Eight testboard men stayed constantly with the operators to assist with this dispatching work, which was indispensable.

Method of Handling Long Distance Calls

Trunk equipment was not available for subscribers to reach the test boards, so hotels were notified and radio stations broadcast the information that emergency calls could be placed from the Sixth Avenue building, and booths with terminals on the testboards were installed for this purpose. Mr. Loveman, in whose building the fire started, was among the first to use this equipment. Messenger service was provided to reach subscribers in the No. 4 office area who had incoming toll calls, and this arrangement was continued until the subscribers' local service had been restored.

During the fire there were a number of long distance calls from fire department officials to nearby towns in connection with additional fire apparatus. The radio studio of station WAPI was near the fire and was used by the fire department as a dispatching point. As is usual, the telephone company had furnished spare circuits to the studio in connection with chain broadcast arrangements which terminated on the test board, and these circuits permitted toll connections to be established to and from out-of-town points.

During Sunday, March 11, six sections of PBX equipment were placed in service for recording long distance calls and five as toll line positions, and these were used to supplement the testboard positions. During the day 333 calls were placed, about 50 per cent of a normal Sunday's business, and 88.6 per cent of the calls were completed. Three sections were arranged for information, operators at them distributing traffic to 12 operators at adjoining tables, where information records, fortunately saved from the Main building, were set up and placed in service at dawn on Monday.

Quick Restoration of Local Service

By Monday morning, 350 lines from Office 4 were being served from the dial unit. In addition to those demanded for public safety, other lines of more than average importance received the first emergency treatment. Since a large number of PBX switchboards, including those at hotels, were involved, about 3,600 telephones, or nearly 45 per cent of the total, had been restored to service within 36 hours.

A surplus of pairs existed in the trunk and tie cables between the Second and the Sixth Avenue buildings, and trunks between the manual and dial offices in these buildings no longer were needed. Transfer of service could be effected by the installation of a 909-pair cable for about 2,400 feet between the Sixth Avenue building and a manhole near the old office. This cable was available in storage in Atlanta, New Orleans, and Louisville, and was ordered Sunday afternoon.

Monday morning the ducts in the conduit runs were rodded and pull-in wires placed. Everything was made ready so that when the cable arrived that afternoon by truck and express it was immediately pulled in place. This was completed shortly after midnight and on Tuesday all splices were made. It was placed in service as the pairs were needed.

All pay stations in the downtown area were served from the old office, and the dial units contained no equipment to which they could be connected. Facilities for operators to attend pay stations were installed in ten strategic locations in the downtown area, including the telephone company business offices and the railroad stations. This afforded substantial relief to the public station situation.

The Problem of Public Telephones

Emergency restoration of the remaining pay station service presented a particularly difficult problem. Six operator positions of suitable equipment would be needed to care for them, together with the measured service lines, on a manual basis, and tentative plans were made to secure these from available surpluses existing within the Southern Bell territory. Before work was started on this basis, a survey of pay station equipment in the outlying dial offices was made, disclosing that 400 lines could be served from them if it was found that they would operate over the long circuits to which they would be connected. In some instances, the wire resistances would be double the usual allowance for dial pulses to operate the selector switches. The possibility of differences in the ground potential between the pay stations and the outlying offices also cast a very dark shadow over the possibility of using this equipment, since such potentials might interfere with the important function of collecting or returning coins.

Emergency situations demand emergency measures. Perhaps the pay stations could be made to work even under these almost absurdly abnormal conditions. Recording meters were connected in line circuits and records over 24 hours were taken of the ground potentials, which fortunately showed them to be small. Trial pay station equipment was set up at the stations which would have the highest resistance in the circuits to the offices and practical tests were made with a number of coins. Various classes of calls were dialed, and the connections were found to be properly made and coins were accurately collected or returned, even with the insertion of additional resistance in the circuits to assure that there were sufficient remaining margins to make the service reliable. This was sufficient proof, and the public pay stations and the more important semi-public ones were temporarily on this basis. An anomalous situation resulted from the pay stations in the heart of Birmingham bearing the recognizable office designation of telephones in the outlying town of Homewood.

The DSA Board Found Usable

Subsequent tests of the results of efforts to dry out the dial special service switchboard indicated that the replacement of certain cables would make these positions at least temporarily operative. This work was at once started and an addition of 600 answering jacks was made in it. Since the cable runs in the building could not be used, a 909-pair cable was extended from the main frame on the first floor up the outside of the building to the switchboard on the fourth floor. The remainder of the pay stations, together with all measured service, were transferred to this switchboard and service temporarily provided on a manual basis. The message rate lines were connected to terminals in dial office No. 3, so that incoming calls could be dialed directly to them. Dials were not installed on these telephones and calls originating at them were automatically extended to an operator, who ticketed the calls and completed them over dial trunks. The pay station lines appeared individually in the DSA switchboard. Originating calls were set up by the operator over dial trunks to the several offices and the coins collected or returned. Incoming calls to the pay station group of numbers were extended to the operators, who completed the connections. Incidentally, the numbers selected for the pay stations operated from this switchboard were such that it will not be necessary to change them when the lines are transferred to the dial office.

The A–B toll traffic to Bessemer, which immediately after the fire had been handled by the small manual office No. 5, was transferred to the DSA switchboard.

The work of installing dials on the remainder of the flat rate telephones was proceeding at the rate of about 600 per day, and this work was completed by Tuesday, March 20. Ten days after the fire, all local service had thus been restored, the great majority of it on a permanent basis. A temporary directory was mimeographed, giving the new numbers of the Office 4 telephones, and this was distributed to telephone customers such as hotels, hospitals, public safety departments of the city, and important business houses. A permanent directory was issued on April 16.

Temporary Toll Switchboard Cut In

The toll switchboard work in the Sixth Avenue building went forward so rapidly that by the evening of Monday, March 12, 28 toll positions were in service. During the day 1,093 toll calls were placed, of which 76.1 per cent were completed. Additions were made on subsequent days until the temporary office comprised six recording positions, 27 toll line positions, and 11 positions of special services such as information and official business. Numerous tables were used in connection with intercept and information service.

The temporary toll switchboard initially was connected to line finder terminals in the same manner as subscribers' telephones for completing toll connections. This arrangement, provided as a matter of expediency, had a recognized deficiency in that the toll operator received no supervision of the connection, which necessitated that she listen in from time to time to ascertain the completion of the calls and any special requirements of the subscribers. As soon as the positions were made operative and service given, measures were taken to improve its quality. Among the first steps was the modification of the cord circuits to operate with standard trunk circuits to the dial offices to give the operators proper supervision of the calls. By Friday the 16th this was completed.

The toll service offered, while not quite up to the high levels of the System standards, was adequate and of sufficient quality to permit retention of temporary facilities until a new toll switchboard could be installed in an orderly manner and without large expenditures for overtime work. Transmission on some switched calls was not standard, but that between the more important points was adequately handled by direct circuits to offices other than Birmingham by the emergency toll layout. The jack space in the positions was not sufficient for all toll lines and local office trunks to appear together in front of all operators, so two special switching positions were provided with one appearance of each toll line in them with trunks from the other toll positions for establishing through connections. The inability to provide all toll lines together with trunks in front of each operator prevented giving toll service with the subscriber remaining on the line.

Toll Switchboard Shipped from Stock

While traffic was satisfactorily handled on these toll positions as an emergency matter, steps immediately were taken toward securing a new No. 3 type toll switchboard. The stock situation permitted the sections of this board to be shipped promptly from the Western Electric Company plant in Kearny, N. J., and they began arriving by the time sufficient space, which had been used for offices on the fourth floor of the Sixth Avenue building, had been cleared of partitions. The switchboard sections were placed in their permanent location upon arrival. The detail engineering work was done in Kearny, by Western Electric and Southern Bell engineers, and the installers were able immediately to proceed with the installation of cabling and wiring. This was completed without overtime work and the switchboard placed in service on Saturday night, May 12, nine weeks after the fire.

This switchboard is the most modern type with the latest features. Key pulsing equipment is provided which automatically dials local numbers in response to operation of a set of 10 keys at each switchboard position, similar to those of an adding machine. Pad control equipment gives automatic adjustment of the transmission over the toll circuits and 26 repeaters or amplifiers were added to effect it. Electric calculagraphs are installed which record the time of toll connections to the second.

Men Rally to the Scene

The Western Electric Company was of inestimable assistance in the restoration work, with a total of 84 of its people reporting to Birmingham. Sixteen were from Chicago, ten from Cleveland, six from Pittsburgh, seven from Roanoke, and others from various scattered points. The District Superintendent of Installation in Pittsburgh had until recently been in charge of the Atlanta district, and was telephoned by a friend on the night of the fire that one of the cities in his old territory was ablaze and that he could hear the news from a radio station in Birmingham. He adjusted his radio set to that station just in time to hear the announcer say that the fire department now had three lines of hose into the telephone building. Knowing what that meant, he arranged to catch the next train to Birmingham.

Installers began arriving on Sunday, and at once set to work helping the Southern Bell forces wherever needed. The Western Electric people, as well as those of the Southern Bell Company, were on the job day and night without rest. After the temporary arrangements had been completed, the new toll switchboard and equipment began arriving and they immediately started work on its installation. The provision of various desks and the addition of about 2,500 lines of equipment to the dial office will keep a large number of them in Birmingham until August.

All Operators Provided For

One hundred and twelve operators had been employed in the No. 4 manual office. Not one of these will lose employment because of the fire. Sixty of them were transferred to other Southern Bell exchanges where the increase in telephone service required the expansion of the forces, and arrangements were worked out whereby they were placed largely in the cities of their selection. The emergency created a need for a large number of operators for auxiliary services. The special service or "0" operator requirements were increased 160 per cent, information 140 per cent, and intercepting calls to Office No. 4 numbers necessitated 15 operators' positions. The great volume of record work required additional clerical help and operators were assigned temporarily to it. The rotary alphabetical files involved the correction of 6,000 listings in six files and intercept records entailed approximately 103,000 entries. Thousands of service orders had to be written for the transfer of telephones to the dial office. Bulletins listing frequently-called firms were prepared and later a complete record of the new numbers of the Office No. 4 subscribers was prepared and mimeographed for limited distribution. In addition, the new directory which was rushed to press was given the usual care in checking and re-checking the listings.

Bad as the Birmingham situation was from a telephone viewpoint, it clearly could have been worse. The fire occurred after the peak of the toll business on Saturday morning, and by Monday the temporary toll office was operating, which minimized the effect on the toll service. The existence of the Sixth Avenue building, with spare dial facilities and space available for a new toll switchboard, greatly facilitated restoration of service. The toll test, telegraph, through line repeaters, and carrier equipment, being in this building, were, of course, undamaged, which resulted in uninterrupted service on the toll circuits through Birmingham and enabled the immediate connection of the temporary toll switchboard. The fact that the Office No. 4 main frame remained in good condition was another fortunate circumstance which permitted the ready transfer of lines to the dial units by the simple expedient of running cross-connections. Had it been damaged, the remaining offices in Birmingham would have been partially paralyzed, since trunks between them pass through this frame.

Local Co-operation and Approbation

The people of Birmingham were appreciative of the work of restoration and their warm approbation was encouraging and their co-operation was most helpful in the orderly restoration of service. The newspapers commented editorially on the effectiveness of the measures which were taken by the Company. The Birmingham *News* stated, in part:

" Birmingham cannot have failed to appreciate the remarkably fine job done by the Southern Bell Telephone and Telegraph Company in restoring service over the thousands of telephones that were put out of order by the big fire of March 10th, in which one of the Company's exchanges was destroyed.

" In an almost incredibly short time all the telephones were put back in service. The restoration was completed within little more than a week.

"Such a performance should not go unnoticed. The Company, its officials here and the workers here and from elsewhere who aided in it deserve the commendation and appreciation of the people of this community."

Despite their own tragedy and reconstruction problem, the Loveman, Joseph & Loeb Company took newspaper advertising space to say:

"Thanks! Telephone Company. Thanks for the old familiar number 7-3131—and thanks also for the speed with which our new switchboard was installed. Your employees are to be congratulated on the manner in which they brought order out of chaos."

F. M. CRAFT

NOTE: The author wishes to acknowledge the valuable assistance of Mr. Judson O'D. Shepherd, a member of the engineering organization of the Southern Bell Telephone and Telegraph Company, in the preparation of this article.

Conference Telephone Service

A LONG distance operator recently received a hurried call from a subscriber. "Operator," he said rather breathlessly, "I want to make six long distance calls and I have only twenty minutes to train time. Will you see how many of them you can rush through?"

"Would you care to speak with several of the parties at one time?" asked the operator.

"Why, why yes, I want to tell them all the same thing. But how—?"

"I will connect you with the conference operator."

A conference call to the six desired persons was completed, and the customer caught his train with time to spare.

This new conference service, which makes it practicable to talk by telephone with several people simultaneously, opens an additional field of usefulness to telephone service.

The history of telephony has been one of ever widening scope of service. The first telephone lines connected two stations only: usually a customer's place of business with his home, or a factory with the company's office. The establishment of telephone exchanges, the building of inter-exchange lines, and the extension of long distance service to a practically world-wide basis have progressively enlarged the possibilities of telephone communication. Until recently, however, telephone service generally contemplated conversation between two individuals only.

Now, various types of conference service are available, making possible simultaneous telephone communication among a group of people, thus affording an excellent new medium for the rapid interchange of ideas among a number of individuals or the dissemination of a personal message to a widely scattered group. Business men may discuss their problems at a round table conference without leaving their desks, whether they are located in different offices in the same building, in different sections of the same city, or in several cities thousands of miles apart. Executives may easily keep personally in touch with their entire organizations, however large or far flung their enterprises may be. Families with children in school or with members in distant states may be united by telephone.

Foreseeing the wide range and variety of business and social uses of the telephone conference, the Bell System has developed several different forms of the service, designed to meet diverse requirements. These include private branch exchange conferences established on the customer's premises; local and long distance conferences established at the telephone central office; and conferences by means of the loud-speaker which makes a telephone conversation audible to a group.

Private Branch Exchange Conference Service

To provide for telephone conferences involving primarily people in the same business organization, arrangements are made at the customer's private branch exchange switchboard (or at the manual portion, in the case of a dial private branch exchange) to permit the attendant to interconnect several telephones. These arrangements consist primarily of special switchboard jacks giving access to a "grouping circuit." A conference connection is established by the attendant using her regular cords to connect the various telephones with this grouping circuit. The usual arrangements contemplate the interconnection of as many as five telephones, two of which may be reached over outside lines. Special arrangements may also be made to meet requirements involving a larger number of telephones.

Private branch exchange conference service has proved particularly valuable to business concerns with various departments located on different floors of a large building or in different buildings. They find that the telephone conference avoids the time-consuming preliminaries of getting every one together in one place; and that, once the conference connection is set up, the conferees, being "busy," are less likely to be called away or interrupted than in a personal conference. Experience has also shown that it is easy to keep a telephone conference brief and to the point, particularly if one person acts as chairman, directing the discussion along previously planned lines and calling on individuals in turn for questions and comments.

Frequent use is made of the private branch exchange conference arrangements at the American Telephone and Telegraph Company's headquarters in handling inter-company as well as inter-departmental business. For instance, a Plant Engineering man, receiving a request for information or advice from some one in an Associated Company, may signal the private branch exchange attendant and ask that certain representatives of the Commercial and Traffic Divisions be put in on a conference connection. The attendant connects the incoming line and the three private branch exchange telephones to jacks of a conference circuit. Each person can then answer questions and contribute ideas on those phases of the problem in which he is particularly involved. The request is handled much more expeditiously and the subject covered more thoroughly than would be possible if the Plant Engineering man had to call each of the others separately, outline the problem, make note of answers to questions and comments, and then call the Associated Company man again and relay this information to him.

Many firms have set up regular routines for the use of telephone conference arrangements in carrying on their businesses. For instance, each of three executives of a certain brokerage house has two private branch exchange telephones with pick-up and hold keys, one for making and receiving routine calls and another, equipped with a lamp signal, for receiving urgent messages. An employee follows the news ticker and is in communication with the floor of the Stock Exchange by private wire. When news or quotations of special interest come in, this employee signals the private branch exchange attendant and says "Flash." The attendant then connects the employee's line and the executives' special lines with the conference circuit and flashes the signal lamps. The executives come in on the conference circuit, hear the report and, if necessary, discuss the situation.

Local Exchange Conference Service

The telephone companies are now establishing, on demand, conference connections through telephone company switchboards, thus permitting several persons to talk together by means of regular telephone connections. This makes conference service available to other than private branch exchange customers, and also provides to private branch exchange customers a more extensive conference service than is feasible through their private branch exchange switchboards. Local conference service, for a maximum of ten or twelve parties, with satisfactory transmission between all telephones, may be provided by means of a bridging circuit. This equipment is usually installed at the toll switchboard, utilizing the high grade toll switching trunks for inter-office connections in order to maintain satisfactory transmission.

All conference calls are handled by operators specially trained for this service. To obtain either a local or a long distance conference connection, the customer calls or dials Long Distance and asks for the conference operator. The conference operator records the details of the required connection, including the calling and called telephone numbers and the names of the particular persons desired, and then releases the calling party telling him that he will be called later. When the person calling has disconnected, the operator comes back to his line over a toll switching trunk and holds it without ringing. She then calls each of the desired persons in turn, telling him he is wanted on a conference connection and will be called again. When all the required persons have been reached and are ready to talk, the operator reaches each again individually, reports that the conference is ready, and connects the calling and called lines with the conference circuit. She then informs the person who originated the call that the conference is "Ready."

If, after attempting to reach all the called telephones on the preliminary call, the conference operator finds that one or more of the desired persons is not available, she holds the other lines, calls the customer originating the conference, reports the situation, and asks for instructions. If he cares to go ahead with the persons available, the operator completes the conference connection. If not, she calls back those whose lines she is holding, tells them that she will call them later, releases all the lines and tries to establish the conference as soon as all the desired persons are available.

Local conference service is still so new that its possibilities for use have hardly begun to be realized. The equipment has been installed in a number of cities, and additional installations will be made as rapidly as sufficient customer demand is developed.

The uses of the service thus far have been interesting and varied. A vice president of a bank periodically calls the managers of nine branches scattered throughout the city to advise them simultaneously of the latest news and quotations received at the main office. The Y. M. H. A. in a large city launched a drive for funds with calls from headquarters to the various neighborhood branches. In this case, 45 branches were reached in a series of five conference connections, each involving the main office and nine branches. The Chairman of the Board of Deacons of a suburban church used to find it next to impossible to get his board together for meetings. Now he calls them all on a telephone conference connection and the necessary business is transacted in a few minutes.

These instances illustrate the great value of local telephone conference service as a saver of time and effort in business transactions and social contacts, where the same message is to be delivered to a number of people at different locations or where agreement among several individuals must be reached. A local conference call may take the place of a series of individual telephone calls or of a group meeting of several busy people coming from different sections of the city. As the public comes to realize its value as a time-saver, this service will undoubtedly attain wide popularity and usefulness.

Long Distance Conference Service

"Happy New Year. A prosperous 1934."

This salutation from St. Petersburg, Florida, was heard simultaneously in Battle Creek, Michigan; London, Ontario; London, England; and Mexico City. Back and forth among these widely scattered cities New Year's greetings were exchanged by a group of business associates on a conference call originated by the head of their company. This novel New Year's party will probably be followed by many others like it, since long distance conference service, even to overseas points, is now generally provided.

Long distance conference connections are made by bridging toll lines together at centers where the necessary equipment has been installed. The equipment required in the case of long distance service is considerably more complex than that for local conferences, since it includes amplifiers and other equipment for offsetting the transmission loss incident to the multiple long distance connections.

Toll conference equipment need not be located at the exchange where the conference call originates nor, in fact, at any of the exchanges where the subscribers involved are located. For instance, for a conference involving Buffalo, Albany, Hartford, and Philadelphia, circuits from each of those points to New York would be bridged together at a New York conference position, that being the nearest point at which toll conference equipment is at present available.

At present, a six party conference is usually regarded as the maximum for satisfactory two-way long distance communication, although in certain cases as many as ten parties can be handled with satisfactory transmission.

The operating procedure on a long distance conference originating in an exchange having toll conference equipment is similar to that already described for local service. When a conference call originates in an exchange not having toll conference circuits, the conference operator in that exchange records all details of the order and passes them to the conference operator at the nearest center having the toll conference equipment. The latter establishes the conference connection in the manner already described, except that contacts with the calling person are handled by the conference operator in the originating exchange.

Many business concerns with a number of branches are finding periodic toll conferences especially useful in their sales work. For instance, the sales manager of a Chicago company has for over a year been holding conferences with a number of branch offices simultaneously by telephone. This enables him to deliver a personal message to all branches in a minimum of time, and to insure that all branches receive identical instructions. Also, it permits discussions in which all can participate, regional managers reporting on conditions in their areas and offering comments and suggestions regarding the general sales plans. Twenty-two cities in the Middle West have been included in the various conferences called by this sales manager and advantage has been taken of the flexibility of the telephone conference method, the offices to be included and the groupings having been varied as seemed most desirable for each particular conference.

Conference telephone service is being used in both the formulation and administration of N. R. A. codes. During recent code discussions, the head of a large concern representing his industry in Washington consulted daily by telephone conference with the other leaders of this industry, most of whom were in New York. A county administrator of the N. R. A. building code calls the dealers in his district, as changes in conditions require, to discuss the situation and formulate a consensus on the various questions that arise. Decisions so reached become standard for the area. Since the builders are often away from their offices, the administrator has found it convenient to file his conference calls in advance, so that all the persons called are notified and hold themselves available at the time specified for the conference. The builders in this county have expressed great satisfaction with the telephone conference method, which saves them each at least half a day's time and some traveling expense on every occasion when a personal conference would otherwise be required.

The long distance telephone conference has already taken its place with other types of telephone service as an aid to the medical profession in its battles for human life. A child was dangerously ill in a New Jersey hospital. The physician in charge consulted simultaneously by telephone with a surgeon in New York and a specialist in Cleveland. The three agreed that an immediate operation and the administration of serum were required. On the termination of the telephone conference, the surgeon started from New York bringing the serum, and prepared, with complete knowledge of the case, to perform the operation.

Long distance conference service is, of course, not confined to business transactions and emergency uses. While a marriage by telephone is still more or less of a news item, the holiday seasons, birthdays, and anniversaries are becoming more and more occasions for family gatherings united by means of a telephone conference. For instance, a college student, unable to go home for Christmas vacation, held a telephone reunion from New York with her mother in Colorado, an aunt in

West Virginia, and an uncle in Tennessee. This family had been separated for several years and all of them expressed the feeling that the conference call was their most valued Christmas present.

A New York business man was recently called to Chicago while his wife was visiting in Pittsburgh. It seemed desirable to leave their son at home so that his school work should not be interrupted. Anxiety was avoided by using conference telephone service to keep the family in touch with one another.

A steady growth of these various types of social uses of conference service may well be anticipated as the public becomes increasingly aware of its availability and moderate cost.

Conference Service with Loud-Speakers

The field of conference telephone service is now being further developed by the use of loud-speakers suitable for connection to regular telephone lines, which enable groups of persons to hear local or long distance telephone conversations. Two types of such loud-speakers are now being made available. The smaller unit has a range of volume which may be adjusted to serve as many as 75 to 100 people under favorable conditions. The larger set is suitable for groups of as many as 250 people. These loud-speakers are furnished either for special occasions or for continuous use, the telephone company taking full responsibility for maintenance, including replacement of tubes. The loud-speaker is associated with the subscriber's regular telephone, and may be used whenever he desires to make a local or long distance conversation over his line audible to a group of people. No special equipment is required for sending messages to be received by these loud-speakers, the regular telephone being used. Telephone connections may be made on demand between two telephones equipped with loud-speakers at one or both locations, or on a multi-point conference basis with loud-speakers at one or more points. These connections, however, are not suitable for the transmission of music, since the transmitters and circuits used for telephone message service are not designed to reproduce as broad a range of frequencies as the microphones and circuits used in high-grade radio broadcasting. Where the customer's requirement is other than that of amplifying an ordinary telephone conversation, special arrangements can, of course, be made for the use of circuits and other equipment of program transmission quality.

The telephone loud-speaker enables an executive to address, personally, groups of employees in distant places, getting his message across with a direct and personal touch and without the possibility of misinterpretation or change of emphasis which might arise if it were passed through organization channels.

Recently, the president of an insurance company made a series of personal talks from his headquarters in Boston to groups gathered in 78 agencies throughout the United States and one in Hawaii. At each agency the talk was amplified by a loud-speaker. The most far-reaching conference of this series included Boston, Mass., Denver, Colo., Portland, Ore., Seattle, Wash., New Orleans, La., San Francisco, Cal., Stockton, Cal., and Honolulu, Hawaii.

At a meeting of executives of another insurance company recently held in New York, it was desired to obtain reports of the results of a sales campaign from team captains located in 27 cities outside of New York and six offices in Manhattan and Brooklyn. This service was arranged by completing 27 sequence appointment calls to team captains at points out of New York in rapid succession and then establishing a conference connection with the six team captains located in the city. A loud-speaker at the main office made the team captains' reports of sales audible to all those present at the meeting. The reports required an average of 32 seconds of conversation time, and the time between conversations averaged about 14 seconds.

Thus the 27 sequence calls were completed and talked on in 21 minutes, which, it is believed, is a new world's record.

No longer need an audience be disappointed when the chief speaker is unexpectedly detained elsewhere. His talk may now come to them by telephone and loud-speaker. The head of a large real estate development company suffered a broken leg two days before the annual convention of his organization. He made the opening address, as scheduled, from his hospital room.

Relatives and friends in distant places need not miss a wedding or other important social function. A wedding ceremony which took place recently in a hotel in New York was picked up by program pick-up equipment and transmitted by means of an ordinary long distance telephone call to the home of the bride's grandparents in Beverly Hills, California, where two loud-speakers had been installed to care for guests in two different rooms. The grandparents and friends, after listening to the ceremony, felicitated the bride and groom over the same circuit and their good wishes were received over a loud-speaker in the New York hotel. This was followed by personal conversations between members of the two parties over regular telephone instruments.

More important than these rather spectacular uses of telephone loud-speakers in emergencies and on special occasions is their recurrent employment as part of the regular business routine.

An advertising executive is finding it convenient to have his copy, layout, and art directors listen around the loud-speaker while a client telephones instructions. They make notes, ask questions and give suggestions which may be passed on to the client. As soon as the conversation is over, each is ready to go ahead with his end of the job and all have a clear understanding of the client's requirements.

A newspaper recently installed a loud-speaker in the office of the managing editor. When a reporter telephones an important scoop, the editor calls in two or three rewrite men who listen to the story and make notes. The story is divided, each writes an assigned part, and the news is on the press in a fraction of the former time.

The president of a large chemical company spends much time in Washington. A loud-speaker in the office of a vice-president in New York enables the president to hold daily conferences with executives. These daily telephone conferences have been averaging thirty minutes' duration.

These various instances are illustrative of the rapid expansion still taking place in the scope of conference telephone service. The service has so recently been generally offered to the public that its uses thus far give only a faint indication of its ultimate possibilities. As in the case of every new form of telephone service, the Bell System is endeavoring to foresee these possibilities and develop them to the maximum extent. This does not mean only, or even chiefly, providing improved facilities for many-point, country-wide and international conference connections such as some of those described in this paper. It means also the development of the less spectacular phases of the new service to the point where they become an accepted part of the ordinary day-to-day routine of business and social communications and thus attain their fullest value to the community.

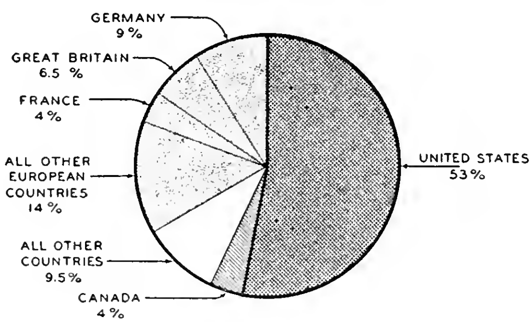
Helene C. Bateman

World's Telephone Statistics

January 1, 1933

ON January 1, 1933, there were 32,941,570 telephones in the world. Of this number, the United States had 17,-424,406 instruments, or about 53 per cent of the world's total. Europe had 11,057,215 telephones, or about 34 per cent of the total; while the remaining 4,459,949 telephones, or about 13 per cent, were distributed among the countries of Asia, Africa, Oceania and the Western Hemisphere exclusive of the United States.

DISTRIBUTION OF THE WORLD'S TELEPHONES
January 1.1933

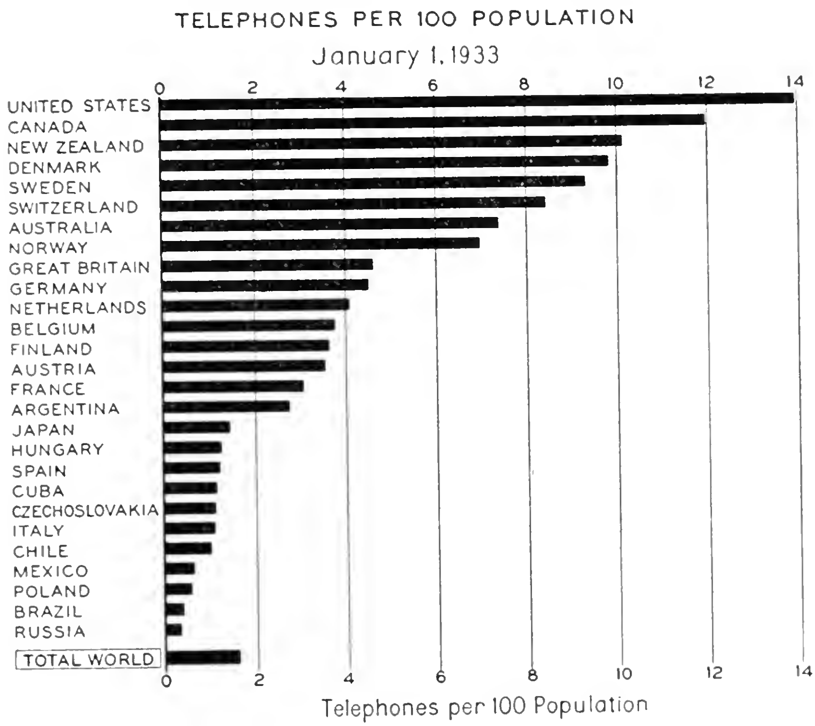


These figures are based upon the latest annual survey of the world's telephone systems made by the Chief Statistician's Division of the American Telephone and Telegraph Company, the results of which have been issued in a pamphlet entitled "Telephone and Telegraph Statistics of the World, January 1, 1933." The tables and charts discussed in the following paragraphs are taken from this bulletin.

Comparative Telephone Development of Countries

The accompanying table, "Telephone Development of the World by Countries," illustrated by the chart, "Telephones per

100 Population," gives the relative standing of the countries of the world in respect of telephone density. As in previous years, the United States, with 13.94 telephones per 100 population, had the highest development. Canada again maintained its relative standing as second on the list, with a development of 11.98. But Denmark, which had previously



ranked third, was passed during 1932 by New Zealand, the latter country reporting 10.12 telephones per 100 population on January 1, 1933, as compared with 9.82 in Denmark. Of the major European countries, Great Britain, with a development of 4.62, was ninth on the list; Germany was tenth, with 4.51; and France was fifteenth, with 3.07 telephones per 100 population. In Asia, the bulk of the telephones are still concentrated in Japan, though its development of 1.44 telephones

TELEPHONE DEVELOPMENT OF THE WORLD, BY COUNTRIES
January 1, 1933

Countries	Number of Telephones: Government Systems	Private Companies	Total	Percent of Total World	Telephones Per 100 Population
NORTH AMERICA:					
United States	—	17,424,406	17,424,406§§	52.89%	13.94
Canada	205,711	1,055,534	1,261,245	3.83%	11.98
Central America	11,175	14,167	25,342	.08%	0.39
Mexico	1,427	98,677	100,104	.30%	0.62
West Indies:					
Cuba	485	44,087	44,572	.14%	1.13
Porto Rico	537	11,337	11,874	.04%	0.74
Other W. I. Places	7,101	13,695	20,796	.06%	0.31
Other No. Am. Places	—	11,379	11,379	.03%	3.14
Total	226,436	18,673,282	18,899,718	57.37%	11.01
EUROPE:					
Austria	239,495	—	239,495	.73%	3.55
Belgium**	299,947	9,914	309,861	.94%	3.77
Bulgaria	19,646	—	19,646	.06%	0.32
Czechoslovakia	148,366	19,530	167,896	.51%	1.12
Denmark♯	15,803	340,770	356,573	1.08%	9.82
Finland	1,651	133,000	134,651	.41%	3.63
France	1,292,254	—	1,292,254	3.92%	3.07
Germany♯	2,960,401	—	2,960,401	8.99%	4.51
Great Britain and No. Ireland	2,146,409	—	2,146,409	6.52%	4.62
Greece	—	17,299	17,299	.05%	0.26
Hungary	110,565	720	111,285	.34%	1.26
Irish Free State♯	32,642	—	32,642	.10%	1.11
Italy*	—	467,066	467,066	1.42%	1.10
Jugo-Slavia	46,112	744	46,856	.14%	0.33
Latvia♯	58,809	—	58,809	.18%	3.04
Netherlands	332,858	—	332,858	1.01%	4.07
Norway*	119,683	78,000	197,683	.60%	6.96
Poland	95,117	88,850	183,967	.56%	0.57
Portugal	10,445	33,086	43,531	.13%	0.64
Roumania	—	51,191	51,191	.16%	0.28
Russia¶	569,111	—	569,111	1.73%	0.34
Spain	—	280,942	280,942	.85%	1.21
Sweden	575,757	1,524	577,281	1.75%	9.33
Switzerland	346,205	—	346,205	1.05%	8.43
Other Places in Europe	100,720	12,583	113,303	.34%	1.37
Total	9,521,996	1,535,219	11,057,215	33.57%	2.01

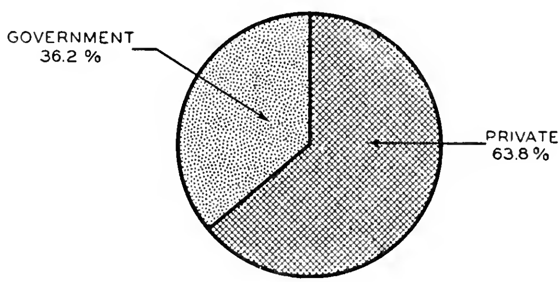
SOUTH AMERICA:					
Argentina	—	318,331	318,331	.96%	2.74
Bolivia	—	2,018	2,018	.01%	0.06
Brazil	700	169,693	170,393	.52%	0.39
Chile	—	44,414	44,414	.13%	1.02
Colombia	2,500	28,652	31,152	.09%	0.34
Ecuador	3,000	3,275	6,275	.02%	0.25
Paraguay	—	2,601	2,601	.01%	0.30
Peru	—	15,279	15,279	.05%	0.24
Uruguay	—	29,378	29,378	.09%	1.49
Venezuela	600	22,000	22,600	.07%	0.69
Other So. Am. Places	2,770	—	2,770	.01%	0.52
Total	9,570	635,641	645,211	1.96%	0.73
ASIA:					
British India‡	22,109	35,183	57,292	.17%	0.02
China	72,000	75,000	147,000	.45%	0.03
Japan‡	965,390	—	965,390	2.93%	1.44
Other Places in Asia	153,708	19,398	173,106	.53%	0.14
Total	1,213,207	129,581	1,342,788	4.08%	0.13
AFRICA:					
Egypt	45,489	—	45,489	.14%	0.22
Union of South Africa‡	116,360	—	116,360	.35%	1.40
Other Places in Africa	95,647	1,198	96,845	.29%	0.09
Total	257,496	1,198	258,694	.78%	0.18
OCEANIA:					
Australia*	484,626	—	484,626	1.47%	7.40
Dutch East Indies	39,750	3,657	43,407	.13%	0.07
Hawaii	—	24,206	24,206	.08%	5.90
New Zealand‡	151,757	3,803	155,560	.47%	10.12
Philippine Islands	6,000	20,516	26,516	.08%	0.20
Other Places in Oceania	3,401	228	3,629	.01%	0.16
Total	685,534	52,410	737,944	2.24%	0.84
TOTAL WORLD	11,914,239	21,027,331	32,941,570§	100.00%	1.61

* June 30, 1932.
** February 28, 1933.
‡ March 31, 1933.
• U.S.S.R., including Siberia and Associated Republics.
§ Includes approximately 13,500,000 automatic or "Dial" telephones, of which about 50% are in the United States.
§§ As reported by the United States Department of Commerce, Bureau of the Census.

per 100 population is far below that of the large Occidental countries. Similarly, Argentina, with a development of only 2.74, holds its lead by a wide margin over all the other South American countries in point of telephone density.

The figures indicate that the type of ownership and operation of national telephone systems is probably of considerable significance as regards the extent to which telephone service is developed. Thus, the United States, where the telephone system is all privately owned and operated, has the highest development of all the countries of the world. The next best developed country, Canada, has 84 per cent of all its telephones

OWNERSHIP OF THE WORLD'S TELEPHONES
January 1, 1933



under private management; while in Denmark, fourth on the list, about 96 per cent of the telephones are operated by private companies. In striking contrast to the high telephone density of these three countries is the relatively poor telephone development of the three major European nations, Great Britain, Germany, and France, where in each case the service is operated exclusively by the government.

Telephones in Large and Small Communities

It is obvious that no system of communication may be considered to be wholly satisfactory unless it is extensively available, not only to the well populated sections of the country, but also to the more sparsely settled regions. It is, therefore,

TELEPHONE DEVELOPMENT OF LARGE AND SMALL COMMUNITIES

January 1, 1933

Country	Service Operated by (See Note)	Number of Telephones: In Communities of 50,000 Population and Over	Number of Telephones: In Communities of less than 50,000 Population	Telephones per 100 Population: In Communities of 50,000 Population and Over	Telephones per 100 Population: In Communities of less than 50,000 Population
Australia*	G.	276,400	208,226	8.35	6.43
Austria	G.	177,175	62,320	7.57	1.42
Belgium**	G.	207,000	102,861	6.09	2.13
Canada	P. G.	681,000	580,245	21.02	7.96
Czechoslovakia	P. G.	60,547	107,349	3.61	0.81
Denmark	P.	167,563	190,437	17.58	7.13
Finland	P.	50,151	84,500	10.49	2.61
France	G.	739,018	553,236	8.36	1.66
Germany♯	G.	1,917,215	1,043,186	7.22	2.67
Great Britain and No. Ireland♯	G.	1,561,800	613,800	5.99	3.01
Hungary	G.	84,218	27,067	4.93	0.38
Japan♯	G.	615,877	349,513	3.36	0.72
Netherlands	G.	216,855	116,003	6.69	2.35
New Zealand♯	G.	58,845	96,715	11.06	9.62
Norway*	P. G.	74,873	122,810	18.53	5.04
Poland	P. G.	111,142	72,825	2.35	0.26
Spain	P.	167,001	113,941	3.54	0.62
Sweden	G.	229,245	348,036	22.45	6.73
Switzerland	G.	155,480	190,725	18.00	5.88
Union of South Africa	G.	63,400	52,200	6.46	0.71
United States	P.	9,842,371	7,582,035	19.52	10.17

Note: P. indicates that the telephone service is wholly or predominantly operated by private companies, G. wholly or predominantly by the Government, and P.G. by both private companies and the Government. See table, "Telephone Development of the World, by Countries."

* June 30, 1932.

** February 28, 1933.

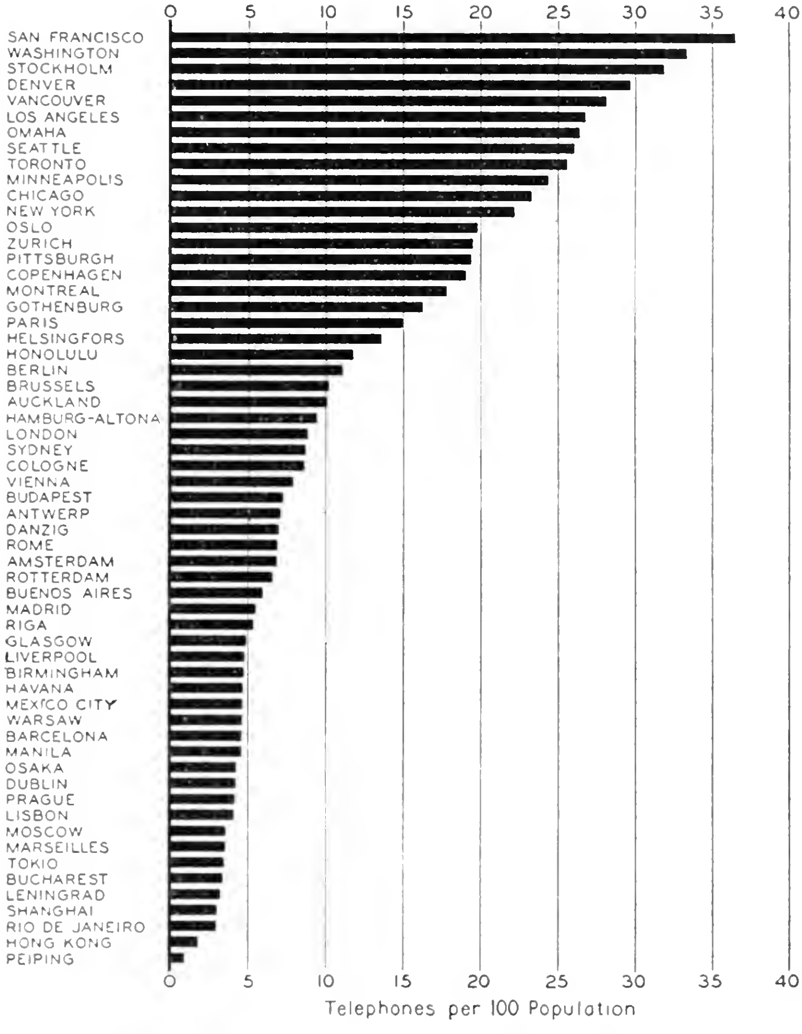
♯ March 31, 1933.

interesting to consider the table "Telephone Development of Large and Small Communities" from this particular standpoint. One fact that immediately stands out is that in the United States ample telephone facilities are provided not only in the more densely populated areas, but also in the smaller communities. In fact, the United States figure of 10.17 telephones per 100 inhabitants in communities of less than 50,000 population shows that telephone communication facilities in the American rural districts are more extensively available, relative to population, than are similar facilities in all other countries *as a whole,* with the single exception of Canada. Strikingly in contrast to this high telephone development in the smaller communities of the United States are the corresponding figures for the large European countries. For example, Great Britain has only 3.01 telephones per 100 inhabitants in communities of less than 50,000 population, while similar figures for Germany and France are 2.67 and 1.66, respectively. In other words, so large a proportion of the telephones in these European countries is concentrated in the urban centers that, compared to American standards, service in their small town and rural areas may be said to be practically non-existent. Here again, private initiative seems to have contributed more to social welfare than has government operation.

Telephones in Large Cities

Of the first 12 cities shown on the accompanying chart, "Telephones per 100 Population of Large Cities," nine are in the United States. As in previous years, San Francisco heads the list, with 36.49 telephones per 100 population; and Washington is second, with a telephone density of 33.29. Then follow, in order, Stockholm with 31.83, Denver with 29.67, and Vancouver with 28.09 telephones per 100 population, respectively. Chicago, the eleventh city on the list, had a telephone development of 23.62; New York is next with 22.16. It is interesting to compare the development of New York with that of the large capital cities of Europe. Thus Paris, nineteenth on the list, had a telephone density of 14.97; Berlin, twenty-

TELEPHONES PER 100 POPULATION
OF LARGE CITIES
January 1, 1933



second, had 11.07; while London, twenty-sixth, had a telephone development of only 8.84.

TELEPHONE DEVELOPMENT OF LARGE CITIES
January 1, 1933

Country and City (or Exchange Area)	Estimated Population (City or Exchange Area)	Number of Telephones	Telephones per 100 Population
ARGENTINA:			
Buenos Aires	2,910,000	172,100	5.91
AUSTRALIA:			
Adelaide	326,000	27,656	8.48
Brisbane	334,000	24,715	7.40
Melbourne	1,028,000	92,253	8.97
Sydney	1,262,000	106,472	8.68
AUSTRIA:			
Graz	167,000	8,088	4.84
Vienna	2,000,000	157,432	7.87
BELGIUM:			
Antwerp	530,000	37,363	7.05
Brussels	958,000	97,210	10.15
Liege	427,000	21,605	5.06
BRAZIL:			
Rio de Janeiro	1,700,000	49,850	2.93
CANADA:			
Montreal	990,000	175,672	17.74
Ottawa	185,700	36,501	19.66
Toronto	756,800	193,885	25.62
Vancouver	191,000	53,644	28.09
CHINA:			
Canton	1,000,000	7,300	0.73
Hong Kong	850,000	14,620	1.72
Peiping	1,500,000	12,162	0.81
Shanghai	1,500,000	44,605	2.97
CUBA:			
Havana	750,000	35,208	4.69
CZECHOSLOVAKIA:			
Prague	890,000	37,329	4.19
DANZIG:			
Free City of Danzig	240,000	16,765	6.99
DENMARK:			
Copenhagen	798,000	151,727	19.01
FINLAND:			
Helsingfors	260,000	35,183	13.53
FRANCE:			
Bordeaux	265,000	18,457	6.96
Lille	202,000	16,334	8.09
Lyons	665,000	33,471	5.03
Marseilles	860,000	30,407	3.54
Paris	2,900,000	434,066	14.97
GERMANY:#			
Berlin	4,241,000	469,270	11.07
Breslau	618,000	40,890	6.61
Cologne	743,000	63,898	8.60
Dresden	700,000	58,211	8.31
Dortmund	585,000	23,225	3.97
Essen	649,000	28,426	4.38
Frankfort-on-Main	635,000	61,427	9.68
Hamburg-Altona	1,636,000	153,547	9.39
Leipzig	771,000	64,879	8.42
Munich	736,000	73,569	10.00
GREAT BRITAIN AND NO. IRELAND:#			
Belfast	415,000	17,516	4.22
Birmingham	1,188,000	56,027	4.72
Bristol	414,000	20,196	4.88
Edinburgh	442,000	30,497	6.90
Glasgow	1,185,000	57,833	4.88
Leeds	510,000	23,224	4.55
Liverpool	1,190,000	56,983	4.79
London	9,090,000	798,153	8.84
Manchester	1,097,000	63,712	5.81
Newcastle	470,000	19,229	4.09
Sheffield	516,000	19,287	3.74
HAWAII:			
Honolulu	138,000	16,189	11.73
HUNGARY:			
Budapest	1,021,000	73,928	7.24
Szeged	138,000	1,998	1.45
IRISH FREE STATE:			
Dublin#	419,000	17,601	4.20

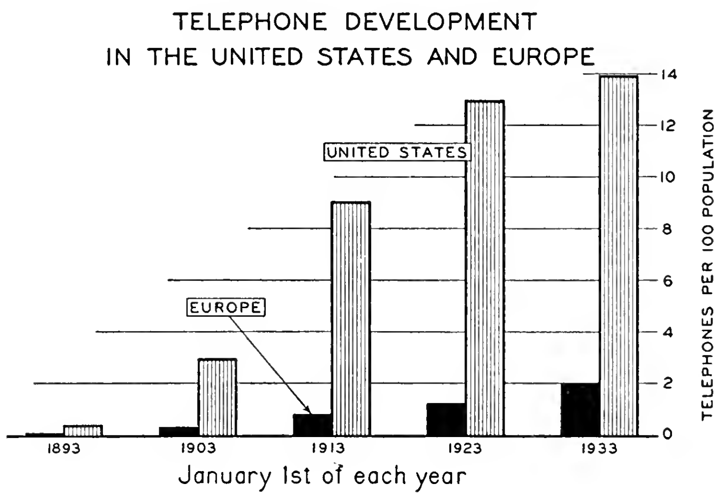
TELEPHONE DEVELOPMENT OF LARGE CITIES (Concluded)
January 1, 1933

Country and City (or Exchange Area)	Estimated Population (City or Exchange Area)	Number of Telephones	Telephones per 100 Population
ITALY:			
Genoa†	650,000	29,153	4.49
Milan	1,013,000	82,120	8.11
Rome†	945,000	65,173	6.90
JAPAN:♯			
Kobe	820,000	30,933	3.77
Kyoto	1,000,000	39,219	3.92
Nagoya	960,000	31,489	3.28
Osaka	2,600,000	110,740	4.26
Tokio	5,300,000	184,034	3.47
LATVIA:			
Riga♯	406,000	21,732	5.35
MEXICO:			
Mexico City	1,100,000	51,492	4.68
NETHERLANDS:			
Amsterdam	775,000	53,080	6.85
Haarlem	155,000	11,505	7.42
Rotterdam	615,000	40,310	6.55
The Hague	500,000	47,283	9.45
NEW ZEALAND:			
Aukland♯	210,000	21,011	10.01
NORWAY:			
Oslo*	250,000	49,562	19.82
PHILIPPINE ISLANDS:			
Manila	388,000	17,540	4.52
POLAND:			
Lodz	850,000	13,679	1.61
Warsaw	1,200,000	56,100	4.68
PORTUGAL:			
Lisbon	612,000	24,823	4.06
ROUMANIA:			
Bucharest	600,000	20,252	3.38
RUSSIA:			
Leningrad	2,250,000	72,349	3.21
Moscow	3,000,000	106,776	3.56
SPAIN:			
Barcelona	1,000,000	45,200	4.52
Madrid	950,000	52,116	5.49
SWEDEN:			
Gothenburg	251,000	40,746	16.23
Malmö	131,000	20,005	15.27
Stockholm	438,000	139,407	31.83
SWITZERLAND:			
Basel	149,000	28,102	18.86
Berne	113,000	22,019	19.49
Geneva	145,000	25,860	17.83
Zurich	260,000	50,659	19.48
UNITED STATES: (See Note)			
New York	7,114,000	1,576,616	22.16
Chicago	3,521,000	831,679	23.62
Los Angeles	1,357,000	362,597	26.72
Pittsburgh	1,000,100	193,838	19.38
Total 10 cities over 1,000,000 Population	21,894,600	4,618,727	21.10
Milwaukee	745,100	138,772	18.62
San Francisco	672,000	245,196	36.49
Washington	587,800	195,683	33.29
Total 9 cities with 500,000 to 1,000,000 Population	5,980,000	1,236,351	20.67
Minneapolis	498,600	121,456	24.36
Seattle	411,400	107,083	26.03
Denver	295,500	87,682	29.67
Hartford	242,000	52,869	21.85
Omaha	233,800	61,691	26.39
Total 34 cities with 200,000 to 500,000 Population	10,270,500	1,918,542	18.68
Total 53 cities with more than 200,000 Population	38,145,900	7,773,620	20.38

NOTE: There are shown, for purposes of comparison with cities in other countries, the total development of all cities in the United States in certain population groups, and the development of certain representative cities within each of such groups.

† January 1, 1932.
* June 30, 1932.
♯ March 31, 1933.

The telephone development of a greater number of cities is shown in the accompanying table, "Telephone Development of Large Cities." Of particular interest are the figures relating to the telephone development of the American cities grouped together in various population classes. Thus, the total of 53 cities with more than 200,000 inhabitants, representing a combined population of 38,145,900, had an average development of 20.38. No single large foreign city has a telephone development exceeding this figure, with the exception of Stockholm and the Canadian cities of Vancouver and Toronto.



When the number of telephones in each of the foreign capital cities is compared with the total telephones in the corresponding country as a whole, the fact already stated above as regards the relatively high concentration of the telephone service in the urban centers of the foreign countries is brought out still more emphatically. Thus London, with its 798,153 telephones, had about 37 per cent of all the telephones in Great Britain; Paris, with 434,066 telephones, had more than 33 per cent of all the instruments in France; while the four cities of Berlin, Hamburg-Altona, Leipzig and Munich had more than one-fourth of the total telephones in Germany. On the other hand, New

York had only 9 per cent, and Chicago less than 5 per cent, of all the telephones in the United States.

The chart, "Telephone Development in the United States and Europe," indicates the substantial margin by which the United States has maintained its supremacy in telephone facilities over Europe since the year 1893. It shows, furthermore, that even as far back as thirty years ago, the United States was better developed telephonically than Europe is at the present time.

CLEMENT J. KOUKOL

Adventures in Communication

A Lecture Presented under the Auspices of the Massachusetts University Extension Division, as Part of a Series "Adventures in Civilization," Boston, Massachusetts, March 5, 1934.

FROM the dawn of civilization through the days when the Greeks ran over the rugged terrain between Marathon, Sparta and Athens, to this modern era when messages are borne to the far curves of the earth by invisible, intangible, imponderable electric waves, communication has had its full share of adventure.

Many adventures in communication have been adventures in thought and imagination, as well as those where physical risk, or chance, is a factor. In fact, it seems that the word "adventure" has taken on a meaning somewhat different from that given in the dictionary. Risk, chance, hazard, are involved in adventure, according to the dictionary. I shall assume, however, in my remarks today, that adventure also connotes an interesting, stimulating, challenging enterprise. It is an effort toward some accomplishment—an enterprise that stirs man's imagination and challenges his intellect. It is this point of view, which I think prevails in Whitehead's book "Adventures of Ideas," in Fosdick's "Adventurous Religion" and in the three David Grayson books, "Adventures in Contentment," "Adventures in Friendship" and "Adventures in Understanding," that I shall take in presenting to you "Adventures in Communication." They will not involve physical suffering, stamina, or hairbreadth escapes, but they will be adventures nevertheless.

Adventures in Ponderables

The development of communication has been in two contrasting fields of endeavor, in the first of which communication was dependent upon transportation. In this epoch a message had a discrete existence; it was a ponderable, tangible and visible something. A letter, a document, a sign or symbol on paper, or some physical object was transported. Great adventure centers around the courier, the pony express, the fast mail, the clipper ship, the airplane, the ocean liner, the automobile. Therefore, this aspect of communication has actually involved developments in transportation. In fact, the message was at first, in practically all cases, the one item to be transported.

It was probably in the Orient that trained runners were first employed to carry messages. The courier of the 15th century B.C. hastened with large and heavy letters of unbaked clay, written in cuneiform script. When such messages had been written, an embassy and a heavily armed escort protected the messenger from marauding bands. Strangely enough to us of the 20th century, the embassy carried valuable gifts to insure a welcome for the message.

It is important to point out that messages during these early days had little to do with individuals. Messages were almost entirely between governments, between princes and potentates. Military or naval considerations determined the degree of their importance.

It has ever been an adventure to increase the speed of the message, for it has ever been man's objective to overcome the barriers of time and space. At first both the messenger and the message were placed on horseback. Later, the message alone was dispatched by stage coach, by boat, by train, by airplane. Herodotus, 480 B.C., writes of mounted couriers during the reign of Xerxes as follows:

> It is said that as many days as there are in the whole journey, so many are the men and horses that stand along the road, each man and horse at the interval of a day's journey; and these are stayed neither by snow, nor rain, nor heat, nor darkness from accomplishing their appointed course with all speed. The first rider delivers his charge to the second, the second to the third, and thence it passes on from hand to hand.

On the facade of the New York Post Office appears a well known adaptation of this famous description:

Neither snow nor rain nor heat nor gloom of night stays these couriers from the swift completion of their appointed rounds.

An unique method of speeding up message delivery, employed in 1544 in Germany, was the use of stilts to lengthen the stride of letter carriers.

On April 3, 1860, the Pony Express in America began trips between Missouri and California, a distance of 2000 miles. Service was suspended in 1861 on completion of the transcontinental telegraph line. In October, 1783, a stage coach line between Boston and Hartford was established. Later the line was extended to New York. This line had the exclusive government mail contract. A contemporary wrote: "By this unparalleled speed a merchant may go from Boston to New York and return again in 10 days, which is truly wonderful." In 1858 the first overland mail coach reached St. Louis, having covered the round trip from San Francisco in the remarkable time of 24 days and 18 hours. The Government was the principal user and paid several hundred thousand dollars annually for the transportation of letters.

These examples in America of using the speed of animals rather than the speed of men presuppose a mail service. It was in 1691 that mail service was established by a grant from William and Mary. Post riders were dispatched between Portsmouth, New Hampshire and Virginia weekly except during the winter, when trips were made fortnightly. The journey required some 48 days. It was America's first organized system of communication. In 1792 the Congress of the United States enacted the first comprehensive postal law. This step had been strongly urged by Washington in his annual message of 1791. He referred to posts as an instrumentality for spreading the knowledge of the laws and the proceedings of the Government. It is interesting to observe that in his advocacy of the post, Washington at that time did not envision it particularly as a means of communication between individuals. The social importance of mail service was not generally accepted by contemporary leaders. There was little consideration of it as a factor in the enlargement of men's friendships and horizons. One of the greatest adventures in communication, therefore, is that which resulted in the exchange of letters and relatively small packages between all classes of people throughout the commonwealth.

The next attack on the limitations of time and space came with the harnessing of a new agent, steam. The motive power of legs was discarded. Soon the iron horse, with rapidly revolving wheels supplanting beating hoofs, carried letters and packages with greatly increased speed.

On July 4, 1828, construction of the Baltimore and Ohio Railroad began—the first public railroad in the United States. In 1830 a line 14 miles long was opened between Baltimore and Ellicott Mills. In July, 1831, the iron horse of the DeWitt Clinton train made its first trip between Albany and Schenectady, 17 miles, in an hour and 45 minutes. In June, 1870, the first train across the United States reached San Francisco. I need not tell you of the speed of airplanes as they carry mail across the continent today. In them, still a new agent has been harnessed—the internal combustion engine.

Of all methods of carrying messages, none are more stirring than that of carrier pigeons. The discovery of the homing instinct of certain pigeons, the training of the bird and the development of this instinct to such a high degree, the sheer stamina to fly so swiftly, 80 miles per hour, and for such long distances, upwards of 500 miles,—these are fascinating phases of the enterprise. Pigeons had been used from the earliest times in recorded history. The Bible story of the flood tells of Noah's release of a pigeon. It is recorded that pigeons were dispatched by merchants to their agents inland to announce the arrival of ships. Victors in the Olympic games in 1750

B.C. conveyed by pigeons the tidings of their triumph to the home officials. Today these birds still perform valuable services, particularly in times of war.

I have mentioned the quotation from Herodotus that appears on the New York Post Office. In concluding the discussion of adventures in ponderables, let me read to you some lines on the facade of the recently completed post office at Hartford, Connecticut:

> Across unbounded reaches of the sky,
> Over long trails upon the land,
> By lakes, by rivers and the tractless sea,
> In tempest and in calm, by day and night,
> We speed at your command and bear
> The tidings and the treasures of mankind.
>
> J. Barss

An Adventure in Waves

Coincident with adventures in communication having to do with the tangible and ponderable were adventures in waves. The major portion of my recounting of adventures in communication will be concerned with adventures in waves—adventures in the realm of the intangible and imponderable. After discussing briefly adventures in sound and light communication, I shall come to what is probably the greatest adventure of all—adventure in electric waves. We shall then be adventuring with a carrier of messages which is intangible, imponderable, invisible and inaudible. The visibility and audibility at the transmitter and receiver are secondary effects produced by electricity, but en route the vehicle, the carrier of the message, sweeps through space or over wires without direct cognizance in any way on the part of human beings. Time and space receive their knockout blow when electric waves are taught "to get the message through."

Adventures in Sound Waves

Perhaps the first of the early great adventures in communication was that of man learning to use sound, not entirely imponderable but highly so. How this came about and how many million years of struggling and experimentation were required before men utilized sound waves to convey information from his brain to another brain is not within my province to discuss. Very likely man soon learned that sound, a vibration in the air which he also breathed, had limitations as a communication system. He could shout, but only over relatively short distances could he be heard. Wind and noise also impaired his ability to shout long distances. It is likely that the phenomenon of echo also taught some perspicacious cave man that sound traveled with finite speed. To the early man, the speed of sound was greater than that of anything else in his environment. Some keen mind might have surmised, from observation and meditation about echoes, that even if one shouted with a voice louder than Stentor's whose cry was as loud as that of fifty other men, facility of conversation would be impaired because finite and appreciable time would be required for sound to carry his words to the listener and to carry words back to his ear. So sound as a two-way medium of communication was not adapted to the basic objective of communication —to break down the barriers of time and space.

However, there have been many instances where sound was used for the practical purpose of signaling in one direction. The thunderclap was an early reality to man. No such loudness of sound as the thunderclap could be produced by man, so he soon appreciated that some sort of relay of sounds would have to be accomplished. Just as a man leaped on a fresh horse, in a sense a relay system, so the sound waves (perhaps one may say they get tired, too; at least they lose their energy en route through absorption and spreading in all directions) can work a relay in a man's brain, prompting him to set off a new sound which will carry on to another observer some distance beyond. The African aborigine and his tom tom and the beating of stones lying on the ground are notable examples of this system.

In 1825 occurred a most interesting adventure in sound waves and relays. At the opening of the Erie Canal a succession of salutes of cannons stationed between Buffalo and New York was used to announce in New York the starting of the first boat from Buffalo. One hour and 20 minutes was required, the overall speed of the message being 320 miles per hour. Since sound travels 770 miles per hour, 33 minutes would have been the time for sound to travel all the way. In other words, out of the total of 80 minutes, sound itself used 33 minutes, and man's activities required 47 minutes. The relays used up more time than did the sound waves.

Adventures in Light Waves

Sound communication systems would be quite unbearable as a commercial enterprise. Not only does sound travel slowly and relatively short distances, but it is too naïve. It reveals itself too readily to everyone's ears. The air would be full of shrieks, howls and explosions; the fogbound ship would be a haven of quiet even with its fog horns and bells. A swifter and more suitable wave system which was utilized contemporaneously with the transportation of messages by sound was light. Very early in man's history vision itself was a concomitant of speech in communication. A gesture, a nod of the head, a smile, a frown, a grimace—all of these were parts of face-to-face conversation and very soon might have been recognized as communication in themselves. No more thrilling chapter in the consideration of adventures in communication could be found than in the recital of the use of light waves. Reflection of the sun's rays by mirrors, the use of smoke, fires, flags, semiphores, lanterns, lighthouses—these and many variations of them have had and still have a part to play in communication. Greater speed and a longer range of signaling was the answer of light waves in breaking the barriers of time and space. Light's own speed as a wave phenomenon was so far above that of sound waves that the only limit to speed of signaling was the speed of operation of the signaling mechanism. As was the case in the Erie Canal episode, where more time by about 140 per cent was consumed in relay operation than in transmission of sound, so with light, practically all the time of signaling was consumed by the mechanism. The light rays have a speed of 186,000 miles per second, sufficient to travel 7 times around the equator in a second. When a vehicle of such speed was utilized for man's purposes, that was an adventure.

In the play "Agamemnon" by Aeschylus, signal fires carried the news of the fall of Troy to Argos in 1084 B.C. Beacon fires were placed on Mount Ida, Athos, Citheraon and on intervening eminences. Beside them sentinels were placed to watch for the signal and in turn set fire to their own. When the city fell, a nearby fire was kindled and beacon after beacon sprang into flame on the route towards Greece.

The ancient Britons used beacon fires to warn the country of the approach of an enemy. Beacons were so frequently used in early English history that certain hills were actually called Beacon Hills. I believe that the hill on which we are this very moment is sometimes referred to as Beacon Hill, Boston. From its height a beacon fire may have blazed up on many occasions. I do recall something about hanging a lantern in the Old North Church, one if by land and two if by sea.

The news of the sighting of the Invincible Armada in 1588 was sent all over Great Britain by a long chain of beacons stretching from Cornwall to Cheviot Hills, the boundary line between England and Scotland. Macaulay tells of the remnants of these beacons "still to be seen on the capes of the seacoast and on many inland hills."

On the night of June 21, 1887, a re-enactment of beacon fire communication was a part of the Queen Victoria Jubilee Celebration. "Hill answered to hill, until at last all the uplands of Great Britain were alight from the tiny summits of Scilly. The signals went north to Midlothian shores tinged with ruddy glow." An English friend of mine recalls with great interest this re-enactment of an adventure in communication as one of many great spectacles in the Victorian Age.

In the realm of visual signaling, an interesting adventure was the semiphore system of J. R. Parker of Boston. Semiphores are mechanical arms which are like a traffic officer's arms signaling STOP and GO. In 1833, Parker personally managed a 12-mile line of semaphores extending northward from Boston along the coast. The line was in operation 7 years, was operated by 5 persons employed from sunrise to sunset, and messages were conveyed the 12 miles in 2 minutes —which was real speed in those days! From a point along the shore signals were sent to the wharf, and it is recorded that 7000 arrivals of vessels were signaled for the benefit of the commercial interests of Boston business men.

I have searched with some care for more information relating to these earlier sound and visual adventures. Aside from the Erie Canal episode, in which sound took 80 minutes to go 428 miles instead of 33 minutes, and the Parker semaphores in which light required 2 minutes to go 12 miles instead of 1/15,000th of a second, I have found but few references to speed and only inferences as to distance. It would be interesting to know how long it took for a light signal to travel from Troy to Argos in 1084 B.C. and compare the average speed with that from Scilly Isle in Wales to Edinburgh by beacon fires as was done in 1888 during the Queen Victoria Jubilee.

Adventures in Electric Waves

Contrary to popular opinion, electricity is not in its infancy. High school graduation essays notwithstanding, the surface of electrical utilization has been more than scratched. Twenty-four centuries ago Thales of Miletus, of Greece, is supposed to have recorded observations about electrical phenomena. Ever since that day electricity has been the subject of continuous experimentation, but always the discoveries pertained to isolated facts which admitted of no correlation or useful application. Finally this violent phenomenon of nature as exhibited in lightning flashes, the catastrophic effects of which are equalled only by earthquakes and floods, was tamed and harnessed and understood. Electricity is generally regarded as a 20th century or perhaps a 19th century subject. Our conceit is, however, jarred by realizing that in 1733, Dufay, a French scientist, wrote a history of electricity. In 1767 Joseph Priestley who, I believe, was the discoverer of oxygen, published another history of electricity. But apropos of our adventure of discussing adventures in communication, what did electricity offer as a vehicle, a carrier, a transporter of messages?

In 1730 Stephen Gray, an English student of natural science, did an interesting and adventurous experiment. He charged a metal body with frictional electricity. One charges one's own body by scuffing one's feet over thick carpets and gets a slight shock when the hand touches a metal door knob. The charged metal sphere of Gray's, however, was connected by a wire to a down feather at a distance of 1000 feet. The feather would move at the far end of the wire when the near end was touched to the sphere. During these experiments the distinction between conductors and insulators was recognized. The day of this experiment is really a most significant one in the annals of adventures in communication.

In 1745 William Watson sent a charge of electricity to a point 6 miles away where the arrival of the electric charge gave a spark and ignited some hydrogen and oxygen in an enclosed vessel. This wa. a forerunner of the automobile spark plug. In 1776, an important date in the history of Boston and Philadelphia, Alexandro Volta, an Italian scientist, sent an electric charge from Como 30 miles across the Lombardian Plains to

Milan, where similarly to Watson's experiment, inflammable gases were exploded. That electrical impulses could be transmitted from one point to another through a conductor, whether that conductor was a metal wire or the human body, was adventurously (and here one may say "adventurously" as per the conventional definition), was adventurously demonstrated during these same years when Abbé Nollet sent a shock along a hand-to-hand circle of 180 Royal Guards. On another occasion, over 2500 monks in a line one mile long were electrically shocked.

However, as years went by, electricity was of little practical use. Exploding gases in glass jars, human beings cringing from electric shock, and flitting feathers—none of these offered much promise as receivers to function quickly and surely in a communication system. It was recognized that electrical impulses traveled with incredible speed, practically the speed of light, but sheer speed was not the only talent necessary; the legs of men and beasts, the wings of birds, the noises of sound and the flashes of light were much more tractable and reliable message bearers.

The Adventure of Magnetism

During the years of the 18th century, electricity was electricity, electrical phenomena were solely electrical—one might say the dual personality of electricity had not yet been discovered. The "I" of electricity was known but the "me" was unknown. One must travel to Copenhagen in 1819 to learn of the "me" of an electrical phenomenon. In that year Oersted was engaged in a most significant adventure. He discovered that an electrical phenomenon does not have a discrete and separate existence *per se*, but rather is one phase of a dual phenomenon; he discovered that an electrical disturbance and a magnetic disturbance always accompany each other. Oersted discovered that if you start with what appears to be solely an electrical effect there will be an associated magnetic effect. Conversely Faraday, a truly great electrical adventurer, in 1831 discovered that if you start with what appears to be solely a magnetic phenomenon, an electrical phenomenon will be inextricably bound with it. Figuratively speaking, the dual personality of electricity was revealed.

The phenomenon of magnetic attraction is a bit more tractable and docile than electric attraction. One can handle small horseshoe magnets; nails and tacks can be picked up and compasses moved without the human organism being aware of any shocks or pain. When, therefore, it was discovered that the arrival of the electric current from a distant point could be detected magnetically rather than electrically, a great era in communication had dawned. At the receiving end a compass needle might be moved. By wrapping the wire, carrying the electric current from the distant point, about a small bar of iron, the bar would grip to itself a second small bar of iron placed near it. When the electric current stops, the first bar of iron releases its grip on the second. The magnetic grip is firm and positive, but is serene and shocks no one. The motion of the compass needle or the motion of the iron bar responding to the magnetic grip and release could readily be made to convey information.

The Adventure of Telegraphy

The credit and honor of making a great discovery or applying a great discovery to man's needs seldom belongs to a single individual. Oersted, Ampere, Sturgeon, Wheatstone, Weber, our own Joseph Henry and S. B. F. Morse—all had an important rôle in the adventure of telegraphy. Morse, an artist, had observed during a trip to Europe the fundamental workings of electric currents, compasses and electromagnets and saw that with the perfection of a code—dots and dashes on a piece of paper, or long and short clicks of sound—electricity (and magnetism, too, one must really say) could be made to carry messages. After centuries of research, this most whimsical, this most intangible, most imponderable, most untractable, most unknowable something, but withal the swiftest something in man's environment—this agent Electricity with its shadow, Magnetism, was the David that was to slay the Goliaths, Time and Space.

On January 24, 1838, Morse sent a message by electricity and magnetism over a 10-mile wire circuit. In 1844 a telegraph line between Washington and Baltimore was opened with the historic phrase "What hath God wrought." In 1846 New York and Boston were connected by telegraph lines. In 1861 telegraphic communication between the Atlantic and the Pacific was received by East and West with great enthusiasm.

The development of telegraph service brings to our attention a great adventure—an adventure teeming with hazard, chance and suffering. This adventure might be called the magnificent failure. To connect America to Europe by telegraph was the challenging task. Cyrus Field said it could be done by a cable laid on the bottom of the sea. A cable laid in 1858 had failed. Undismayed though Field was, the public and the engineers were skeptical of his ultimate success. It seemed certain that a telegraphic link to Europe must run westward by land rather than eastward by sea. There was a day when a route to India was thought to be westward by sea rather than eastward by land. To stretch a thread of copper 16,000 miles long from Boston westward to the Pacific Northwest, thence to Alaska, thence by a short section of cable under the Bering Strait to Siberia, across the wild wastes of Russia to Moscow and on to Berlin, Paris, and London, required courageous imagination and herculean labors. Morse said the project was feasible; Congress supported it. William H. Seward, Secretary of State, enthusiastically gave his endorsement. To survey and build 16,000 miles of telegraph line, a good share of which was through unmapped wilderness, was an adventure. Work began in the winter of 1865; in spite of tremendous difficulties and suffering, many miles in the 1800 miles' stretch from Ashcroft, British Columbia, to Bering Strait via Sitka were blazed. The Russians actually started construction on a portion of the line from Moscow eastward toward the Pacific.

Meanwhile Field continued his submarine cable adventures. Few men expected that a telegraph cable could be laid without mishap on the ocean floor. In July 1866, the steamship *Great Eastern* hove in sight at Trinity Bay, Newfoundland. The cable she had been reeling out all the way from England was pulled ashore and telegraphic service by cable between America and Europe marked the completion of another great adventure. The success of one great adventure spelled defeat for another. At once the intercontinental telegraph route became but a memory; vestiges of it are still to be seen in Western Canada; millions of dollars had been lost and many lives sacrificed.

High spirit and good sportmanship were a bright spot in this magnificent failure. Secretary Seward wrote "I would not have the Atlantic cable dumb again, even if thereby I could immediately secure the success of the inter-continental telegraph enterprise."

James Russell Lowell put electricity and its swiftness, the transatlantic submarine telegraph cable, and time and space in a poem—Agassiz:

> The flame winged feet
> Of Trade's new Mercury, that dry shod run
> Through the briny abyss dreamless of the sun,
> Are mercilessly fleet
> And at a bound annihilate
> Ocean's prerogative of short reprieve.

Adventures in Telephony

Amid the great public interest in the success of the transatlantic submarine telegraph cable Emerson had written "electricity must teach his nimbleness to earn his wage, spelling with guided tongue man's messages." So it was; man's message had to be spelled in code. Trained operators at transmitter and receiver had to translate and re-translate the message. Could this agent electricity, that had finally become of very practical value, be made to transmit, not only clicks or dots and dashes, but also words and sentences—speech? Could its nimbleness be taught to voice with facile tongue man's languages?

I am not unmindful of the privilege to speak here in Boston on "Adventures in Communication." It is most appropriate to do so in the birthplace of the telephone. Alexander Graham Bell, working here in Boston and in Salem, discovered that electricity could voice man's languages, that speech could be translated into electric current, could be transmitted by this electric current and, at the receiver, retranslated into the sounds of the original words.

I recall hearing Professor Pupin of Columbia University recite an incident in connection with Bell's success. Pupin, a youth from Serbia, was having great difficulty with the English language. To learn to speak and understand English was of paramount interest and importance to him. In 1876, during the years he was struggling with the language, he went to Philadelphia, and there saw the telephone demonstrated under Bell's own direction. Out of the receiver, emerging from the circular iron disc, came words—English words, Chinese words, Greek words, French words, Serbian words (whichever were spoken into the transmitter). Young Pupin decided that America was no place for him—America, where an iron diaphragm had been taught to speak any language, and he could not learn to speak English. It was best to return to Serbia. He did not return, however.

In 1878 Bell said "The telephone actually speaks and therefore can be used for nearly every purpose for which speech is employed." Of all the agencies employed in communication, the telephone was and is now the most wonderful.

The word itself, "telephone," is meaningful; its etymology is "far sound." Therefore, as soon as it was an accomplished fact that electrical counterparts of man's ear and mouth did exist—the telephone transmitter may be regarded as an electrical ear into which you speak and the receiver as an electrical mouth which speaks into your ear—and that they, together with wires between, could function in "far sound," the next adventure was to speak to more and more people within one community and to farther and farther communities.

Adventures in Wires, Cables, and Switching

A single telephone is of no value. There must be at least two telephones. To be of larger and larger usefulness to an individual, there must be many other telephones to which one may be connected quickly and separately. Two telephones need one pair of wires interconnecting, three telephones need three pairs of wires interconnecting, four telephones need six pairs of wires interconnecting $(4 \times 3)/(2)$, five telephones need ten $(5 \times 4)/(2)$, six telephones need 15 $(6 \times 5)/(2)$, ten telephones need 45. The arithmetic is easy: the number multiplied by the number less one divided by two. One hundred telephones give combinations totalling practically 5000.

Telephone conversation is a private, dual affair. A telephone subscriber, disregarding for the present party lines, must therefore have an individual line from his telephone to either a central office that is a switching center or to every other telephone. It is inconceivable that every telephone have a wire actually running directly to every other telephone. In that event, in each home there would need to be a 50-foot square switchboard with tier upon tier of terminals with a track ladder like that in a shoe store in front, by which connections could be made. Such a scheme is of course fantastic and absurd. It would also be most inefficient; some of the circuits would be used but a little while each day; some of them would never be used. In New York and its environs there were a few years ago 1,400,000 telephones. The required number of pairs of wires without central offices would be one million million. This is roughly one and one-half million times as many as actually used with central offices. Hence switchboards or central offices became an adventure.

With 10,000 subscribers with private lines, there of course must be 10,000 wires running to the central office where the switching is accomplished. Among these 10,000 subscribers there may be 50,000,000 possible connections. In the first telephone switchboard of 1878 at New Haven, Connecticut, there were eight lines; $8 \times 7 \div 2 = 28$ possible switchings. Actually there were about 10 telephones in rural fashion, on each line, so that 80 subscribers were served. In 1882 a complete multiple switchboard with a capacity of 200 subscribers was designed; then came boards with 2400 subscribers; today we have 10,500-subscriber switchboards. By means of individual wires and switchboards in large cities, Boston having 50 central offices, there may be possible interconnections requiring a number with which only astronomers can compete.

Wires, sheer wires—how many there are running from homes and business houses to central offices. To place them, to connect them, this has been an adventure. At one time these telephone wires seemed to be strung everywhere. Myriads of them were visible to the passerby, on housetops, and from building to building along the street. They required tall poles with many crossarms.

These wires and poles were vulnerable to storms and accident. Each wire must be kept from touching any other wire. Could they be put in smaller space? The cable, that is, a lead pipe with wires inside, each wire insulated from its neighbor by a thin sheath of paper about 1¾ thousandths of an inch thick, was the answer. In 1912, 900 pairs of wire, each .025 inch in diameter, could be placed within a lead pipe, outside diameter 2⅝ inches. In 1914, 1200 pairs of wires, each wire .020 inch diameter, could be squeezed in the same size lead pipe. In

1928, 1800 pairs of wires, each .016 inch diameter, were squeezed in the same size lead pipe. All this sounds prosaic—mere wires on poles placed along the street, mere wires in pipes under the ground, but to accomplish it was not prosaic—it was an adventure.

Each day, 72,000,000 telephone connections are made and unmade between persons wishing to talk with each other. The switching may be done by the telephone operator or it may be done by machines. The establishment of connection by automatic machinery has been a great adventure. Among so many permutations and combinations, the operation of the dial by the subscriber directs electrical arms and hands, one may say, to select the pair of wires running to the desired party. Signaling, that is, the ringing of your telephone bell and the signaling between operators before there can be conversation, is in itself no mean adventure.

In the United States there are about 20,000 telephone central offices connecting about 16,600,000 telephones; 87,000,000 miles of wire are involved. Wherever a person may be, some pair of wires in the great network of wires and switchboards of orderly and systematic arrangement, will be selected by a tandem operation of human arms and hands or electrical arms and hands from a gigantic number of possibilities, to reach that person. The magnitude, complexity, orderliness of it all, is shattering.

With adventures go thrills. When one stands at the corner of Summer and Chauncy Streets here in Boston, one cannot see the 40 telephone cables that lie beneath the pavement. In these 40 cables there are 37,180 pairs of wires. They are subscribers' wires, a pair running from each subscriber to the central office. At this busy surface traffic corner there is much greater telephone traffic. Electricity quietly, serenely, unobtrusively, effectively, and speedily carries 5000 conversations every 2.1 minutes during the busiest periods of the day. If either messenger boys, or sound waves or light waves, were the message bearers, traffic congestion, terrible din of noise or blinding, fluttering lights would make this corner unbearable to vehicle and pedestrian traffic.

Adventures in Miles

Telephone—"far sound"! Could electricity carry the voice really afar? The first telephone circuit here in Boston was perhaps 50 feet long. Then came a two-mile circuit between Boston and Cambridge. Then 10 miles; then more miles. It was soon learned that like the legs of men and horses, like the wings of carrier pigeons, even like the iron horse and gas engine, which must be fed now and then with coal and gasoline, the electric waves carrying the voice got tired, figuratively speaking. Just as sound waves and light waves die out after traveling long distances, so did electric waves die out or thin out—attenuate, the engineer says. Large wires, wires as big as a lead pencil, were used to diminish the attenuation, to help the electric waves go farther. But 1000 miles seemed about the limit of distance to which electric waves by the power given them at the start could carry a voice on a pair of wires. The reason they could go no farther was that their power, their vitality, was used up in the circuit along the way. If their power, their vitality, could be dissipated less rapidly, then obviously they could go farther. How to diminish, how to decrease the rate of losing their power, became a great adventure.

Further Adventures in Magnetism

You will recall that I said a while ago that no electric circuit can be thought of as being purely electric. Every electric circuit has a magnetic side to its personality. Through the work of Lagrange, a Frenchman, of Heaviside, an Englishman, Professor Pupin of Columbia University, and Dr. Campbell of the American Telephone and Telegraph Company, it was found out how, purposely and in proper amounts, and at regular intervals, to add magnetism to the circuit so that it became a more efficient medium for electric currents. By placing magnetic coils ("loading" coils they are often called) along the circuit, it was possible to reduce the rate of dissipation of power which the electric waves encountered in traveling along wires. Hence the waves could go farther on their original starting power. For distances even less than 1000 miles, and particularly along wires in cables, these "loading" coils are of great value, and of course with them the "far" aspect of speaking was greatly extended—to 1800 miles or so. These doughnut shaped coils, with iron rings forming the core, and wires wrapped around, like the one I hold in my hand, are placed in large metal boxes to protect them from the weather. You may observe them along the highway where telephone cables parallel the road.

In its theoretical phase, the "loading" coil problem was distinctly a mathematical adventure. This problem afforded abundant confirmation of Bacon's assertion "For many parts of nature can neither be invented with sufficient subtility nor demonstrated with sufficient perspicuity nor accommodated into use with sufficient dexterity without the aid and intervening of mathematics."

Adventures in a Vacuum

Even with "loading" coils to assist the electric current to go farther, and to minimize attenuation, there nevertheless was too much attenuation if the distance was very great, and to span the continent with a telephone circuit was not possible without further adventures. Could more power be put into the original current at its starting point? Could weaker currents be utilized at the receiving point? Could some energy be supplied en route? Could the waning waves be rejuvenated along the way? Could some sort of relay, operating instantly, be placed in the circuit—a fresh horse, as it were, for the pony express, or new powder for explosions along the Erie Canal?

This latter problem was attacked. A slow, bulky relay could not follow all the minute modulations of the human voice being carried electrically. The electric voice must be sent along with renewed power, undistorted, untwisted. A new kind of relay capable of practically instantaneous action without inertia must be sought.

Electricity itself was the answer to the problem. In the years from 1895–1912, much had been studied and learned about electrons and electron streams. Electrons are very tiny atoms of electricity; electron streams are like bullets from a machine gun, millions of them streaming from their source—in one case the incandescent wire within an electric light bulb. These streams, unlike a stream of water or bullets, were practically without inertia; that is, they could be made to speed up or slow down, unlike an automobile, which opposes being made to go faster or being made to go slower after it is going fast.

Three different telephone repeaters, all of them electronic, and one mechanical device of earlier origin, were developed by Bell scientists and engineers. They were given official tests in the early winter of 1914. The telephone repeaters equipped with the 3-electrode vacuum tube gave the best performance. Edison, Fleming, DeForest and Richardson had made important contributions to this 3-electrode vacuum tube. A number of such electrode-tube repeaters were installed on the telephone line connecting New York and San Francisco. In 1915, this 3000-mile circuit was opened and the last barrier of time and space in the United States was smashed. The challenge of time and space had in reality been met by understanding not only how electricity traveled and coursed its swift flight along wires, but also how electricity acted inside of a glass bulb from which the air had been pumped out. There is no magic about a vacuum tube or an amplifier tube. To be sure, it serves and does its part so quietly, so serenely, so effectively and with such great agility that it has been called the modern Aladdin's lamp. However, scientific developments are not matters of magic;

they are matters of understanding. I say again, an understanding of how electricity performed in vacuum and how it was conducted through various gases was responsible for this repeater. And, as one may facetiously observe, there was a lot to understand about nothing.

Today there are about 350,000 amplifier or repeater vacuum tubes in the telephone circuits of the Bell System. On a New York-San Francisco call, 200 repeater tubes perform their very important rôle of adding new power to the electric currents. The power itself is supplied from batteries connected to the repeater.

It takes at most .1 of a second for the voice to make the journey of 3000 miles. Unlike the human-cannon sound-repeaters along the Erie Canal, which used 47 minutes, the time consumed by the 100 vacuum tube relays in tandem is a very small fraction of the .1 second total time.

Adventures in Frequencies

Realizing the rôle that the telephone plays in all countries of the world, one readily assents that electricity has been a fine student of linguistics, speaking with facile tongue the languages of mankind. In so doing, the undulations, that is the risings and fallings, of the electric current follow with faithful fidelity the intonations, inflections, the naturalness, and the articulation of speech. Generally speaking, the vowels of speech are low in pitch; the frequency, that is the swings back and forth each second of time, may be 200, 300, 400, 500, perhaps 1000. The consonants which give the articulate elements in speech require the higher frequencies: 2000, 3000, 6000, 10,000. Now it was discovered that electricity, or rather electric vibrations, were capable of a most astounding range or gamut of frequencies. Electrical frequencies from one vibration per second to 100,000,000 per second can be produced, measured and controlled. The existence of these frequencies cannot be detected directly by the senses of man, that is hearing, feeling or seeing. They can be put to work by man, they can be divided into groups, and each group can carry a message. In other words, it became possible to send more than one message along a wire simultaneously with several other messages. Each message, either telephone or telegraph, has its particular electrical color band, one may say. Even though all the color bands are coursing along the wire at the same time, they do not interfere with one another. When a group of persons are looking at a Corot landscape painting, the various colors of the painting do not get mixed up as they are conveyed by light waves to the separate eyes of the many in the group. Human eyes act as detectors of the several colors. Electrical detectors pick out the several groups of electrical frequencies.

The adventure in frequencies therefore made it possible to transmit four telephone conversations and four telegraph messages over a single pair of wires. The frequencies and the messages have also been distributed to achieve one telephone message and 20 telegraph messages.

Adventures Without Wires

Beethoven was born in Bonn on the Rhine. There he composed his symphonies and played his concertos. Little did he dream that some day his symphonies and concertos were to be heard not only by those actually present in the concert hall but also by thousands and even millions in their homes many miles away. Little did he dream that in his native country the scepter of art was to be passed to a science from which radio was destined to be developed. Almost coincident with his death was the birth in Hamburg of Heinrich Hertz. Later, Hertz lived and worked in Bonn for several years. As music was enriched by the genius of Beethoven, so science and communication were generously endowed by the researches of Hertz. It was Hertz who in 1886 at Karlsruhe for the first time in history experimentally proved the existence of radio waves. By physical apparatus he produced radio waves (really electromagnetic waves) and at a short distance detected them, and of course this was tacit proof that they had been transmitted through space without wires. As I have previously said, electrical phenomena do not exist alone; there are always accompanying magnetic phenomena. Likewise, it is really a misstatement to say that an electric current passes through a wire. From a fundamental and basic point of view the intangible and imponderable electrical and magnetic phenomena in the space around the wires equal, and perhaps exceed, in importance the phenomena within the wire. In other words, the wire is rather to be thought of as a guide, a directive channel for the electric and magnetic disturbances. It was Hertz who made the great discovery that these effects could be transmitted through space without wires. Radio communication stirs the imagination, captures the interest and baffles the understanding of the layman. On many occasions one hears the statement, "Well, I can understand how wires can carry the voice and music but I just can't imagine how they all can come so clearly and loudly right into my home without anything to carry them." Really, however, there is nothing more mysterious, more non-understandable about radio than about an electric motor. The armature or rotor is being twisted about by an invisible force, electromagnetic in character, whose invisible fingers and hands reach through space and clutch the rotor so that it is twisted around and around. The principles of radio are as well understood as the principles of motors and electric lights.

Through his great contributions of the antenna and ground,—that is, holding aloft one wire of the radio transmitter and connecting to ground another wire, Marconi gave greater scope to the electro-magnetic waves of Hertz. The great adventure of Marconi of sending a radio signal across the North Atlantic from Cornwall to Newfoundland marked a new day in long distance communication. If because of this contribution and other great contributions, Marconi is called the father of radio, one must remind oneself that a child is endowed with heritage not only by his parents but also by many ancestors. Also one must remember that a child has many uncles, aunts and cousins: Volta and Righi, other Italians, and Lodge, Braun, Thomson, Hughes, Henry, and Lord Kelvin, are but a few of the older members of the family—the grandfathers and great uncles as it were. More recent members of the family remind one of the old lady who lived in a shoe.

The vacuum tube amplifier that plays such an important rôle in long distance telephony by wire, was also a highly important factor in long distance radio telegraphy and telephony. It was realized that if these amplifiers could be made to handle voice power measured in horse power, then the tiny voice power as it emerges from the mouth and is translated into electric power by the microphone—then this tiny voice power could be made larger and larger and larger at a radio transmitter until it could be projected into space from the antenna with many horsepower of power. So vacuum amplifier tubes of large physical size and large power capacity, compared to tubes in a telephone line or in your radio receiver, are keystone elements in both long distance radio telephony and broadcasting. Adventures with a vacuum, with glass, with electron streams within the vacuum, with metals, have created from nature's storehouse something which nature itself did not produce. Nature lets loose a lightning flash and a blast of thunder. Man's intelligence applied to natural phenomena provides a high power vacuum tube which, without flashing light or roaring thunder, hurls man's voice electrically into space to the antipodes where human ears and human eyes could not have heard or seen the sound or light.

As in wire communication, so in radio communication, telegraphy first spelled man's messages. Later, radio telephony with seven-league boots advanced by leaps and bounds and then radio broadcasting swept into civilization like a hurricane. A number of gold ingots of fact and principle in electricity and acoustics assayed during many preceding years from tons and tons of ore in the crucible of fundamental science were taken by commercially minded men from the treasure chest, the keys of which had been kept unwittingly by science itself, and seemingly in a flash radio broadcasting occupied the stage. But radio broadcasting was not invented in 1920. Several centuries were required to develop it. Without special engineering, radio waves spread out in all directions, and hence are inherently well adapted to one-way communication. Broadcasting captured the imagination of millions—to hear speech and music from many distant points was a thrilling adventure. Directed beams of radio waves are also inherently well adapted as communication links between countries separated by wide expanses of sea or desert and also for communication between shore and ships at sea. From New York are radio telephone links to Europe and South America. From San Francisco radio links reach out across the Pacific to Hawaii, to Java and the Philippines. From London and Berlin and Paris and Holland and Java and Australia, radio systems catapult the spoken word between the far curves of the earth.

Wire telephone systems so well adapted for conversation with one and only one listener within the network of land connections, supplemented by radio links between networks, have made 92 per cent of the 33,000,000 telephones of the world into a single web with many, many threads and wide horizons.

From Boston to Sydney, Australia, is a voice journey 14,000 miles long. In 1/13th of a second, the "Hello" from Boston is carred by electric waves to Sydney. Sound waves would require 18 hours. In 1/13th of a second, sound travels about 80 feet. So one may say by the swift flight of electric waves 14,000 miles of space is squeezed into 80 feet. It is like talking with a man 80 feet away. Time and space so annihilated bring about interesting contrasts. When chilly blasts blow around Boston Common, bathers are diving into the surf at Sydney. Men bundled in fur coats, between deep drafts of hot coffee talk with those sipping iced tea. Whatever day it is in Boston, it will be tomorrow in Australia. If at four o'clock in the afternoon you call a friend in Adelaide, he may express displeasure at being wakened just before dawn and may ask " Why are you calling me yesterday? "

From a mundane point of view, radio waves are space-spanning and time-annihilating. We hear much about the man and the message from Mars. If we did communicate with the man in Mars by radio, I fear the conversation would be somewhat stilted, even if we talked his language. For the radio waves to reach Mars, 3 minutes would be required, and 3 minutes for his answer to come back. This is the minimum time. At another time of year when the planets are in a different configuration, 20 minutes going and 20 minutes returning would be the time. Quite a bashful conversation.

Adventures in Television

Telephone conversation is a very good substitute for face-to-face conversation. Smiles, frowns, and gestures must be imagined from an interpretation of the character of the sound. Could this swift and versatile agent, electricity, carry images, moving images, could one see by electrical waves—that would be another great adventure in communication. If the job is to be done, one must seek electric counterparts of man's talents. As the microphone or transmitter may be regarded as an electrical ear into which you speak and the receiver as an electrical mouth which speaks into your ear in a telephone system, so one must find an electric eye with which to see, to substitute for the human eye in a television system. Also at the remote point, the receiving end, an electric hand equipped with an electric paint brush or electric crayon, as it were, must be made to draw a picture in perhaps 1/16th of a second; that picture must be erased and another picture drawn in the next 1/16th of a second, and so on, and so on for all the time you are seeing your friend or a putt by Francis Ouimet. Such electric eyes and electric hands and brushes have been dug from nature's storehouse of electrical and physical phenomena. Electric waves of great agility and capability to vibrate most quickly and also most slowly, and all the way between most quickly and most slowly, are required. The concept of television, the adventure of seeing at long distance through the medium of electro-optical systems and electric waves, is not of recent origin. Carey in 1875, Ayrton and Perry in 1877, Nipkow in 1884 and Rignoux and Fournier in 1906, made specific experiments in television per se. Davy, Faraday, Hertz, Hallwachs, Elster, Geitel, Geissler, Plucker, Hittorf, were adventurers in the scientific fundamentals. By 1923 several experimenters had succeeded in televising shadows. The presentation of an image of the living form was accomplished in 1926 and 1927. At first, the sending of images was from one room to an adjoining room. Later the distance was extended to miles, 200 miles in fact. Real television, the presentation of an image of a living form, is 8 years old. The first images were very crude. Notable improvement has been made, but the images which have as yet been transmitted are not good enough to warrant acceptance by the public in a commercial sense. Television is complicated, costly, and offers many seemingly baffling problems. Baffling problems—therein lies adventure.

Adventures in Business Enterprise

I have presented to and interpreted for you a number of adventures in the instrumentalities and methods of communication. There are many others of great interest and importance. To break down the barriers of time and space is an achievement, but it is not enough. Communication service, telephone service, must be just that—service. Service which is more and more free from imperfections, errors and delays. To reduce the time necessary to establish a connection seemingly is a prosaic adventure. Instead of waiting 30 minutes, 10 minutes, 5 minutes, one is now told to hold the line while the connection is set up from Boston to St. Louis, to New York, to Washington, to New Orleans, to Seattle. Once trouble had to be taken out of your telephone, your line, your bell box once a month, then only once every 6 months, now only once in a year or two. These appear prosaic tasks but actually are highly important.

The telephone business in the United States was not vouchsafed by guardian angels or Delphian Oracle to be a substantial and successful business enterprise. The telephone business was no sinecure. In spite of many obstacles, some almost fatal, it survived. A policy and purpose—may I say an ideal?—to render the most and best service at the least cost was the objective. Scientists and engineers practically assure technical progress, but without adventurous business management which seeks to conduct the enterprise so that it may be a profitable business, the telephone would not have made the notable progress that it has made. "Profitable" does not mean speculatively and excessively profitable. "Profitable" means profitable to the telephone subscriber, to the public welfare, to the employee, and to the stockholder. Profitable to all parties means the best possible telephone service at the lowest cost consistent with financial safety. To conduct business thus is truly an adventure, comparable to wires, waves, electrons, and frequencies. It is a long run adventure but nevertheless an adventure.

In this adventure of management and conduct of telephone service as a business enterprise, there is one factor which does involve, to a pronounced degree, risk, chance and apprehension—a factor where a miss is as bad as a mile. This factor is public reaction, public opinion. When new developments bring changes in communication facilities and service, the big question is not whether the technical and operating features of the venture will work satisfactorily. These have been tested and tried in the laboratory and in the field. The big question is whether the new facilities and methods will be accepted in good spirit or in critical spirit by the public. Will these facilities and methods be suited to the needs and the likes of the public? Will the public believe you? It may listen to your aims and objectives and even your ideals, but will it believe you? That is the gamble.

An ancient philosopher said that continued recourse to experimentation is but a device of feeble minds, an attempt to discover, in a rude manner, what we should know by calculation and logic. I doubt whether many of the great adventures in communication would have been achieved solely by calculation and logic. What new and worthwhile successes to be achieved by calculation and logic or experimentation or both, are ahead, no one knows. We do know we shall keep on calculating and experimenting and shall try to do both with imagination, but what is ahead no one knows. That is the adventure.

J. O. PERRINE

BELL TELEPHONE QUARTERLY

. XIII — OCTOBER [illegible] — No. [illegible]

THE TELEPHONE [illegible]
METRO[illegible]

BUYING [illegible] STORES

TELE[illegible]

THE INTERNATIONAL TELEPH[illegible]

SIGNIFICAN[illegible]
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BELL TELEPHONE QUARTERLY

A Medium of Suggestion
and a Record of Progress

CONTENTS FOR OCTOBER 1934

PAGE

The Telephone Problem in the World's Largest Metropolitan Area —*Kirtland A. Wilson* 233

Buying by Telephone at Department Stores—*John M. Shaw* 267

Telephone Power Plants—*G. L. Weller* 289

The International Telephone Conferences of 1934 —*H. E. Shreeve and H. S. Osborne* 303

Significant Changes in the Occupational Distribution of the American Population—*R. L. Tomblen* 309

Notes on Recent Occurrences 327

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Address all communications to

INFORMATION DEPARTMENT
AMERICAN TELEPHONE AND TELEGRAPH COMPANY
195 Broadway, New York

Contributors to this Issue

KIRTLAND A. WILSON

After attending New York University, Mr. Wilson engaged in reportorial and editorial activities with the *Brooklyn Daily Eagle*, the *New York Herald*, *Daily Financial America*, and with business and trade publications until 1918, and in publicity work for business, civic, and welfare organization until 1928. Co-author of " Informing Your Public," published in 1924. Advertising and General Information Department, New York Telephone Company, 1928–.

JOHN M. SHAW

Educated abroad. After a varied business experience, served in the U. S. Army Ambulance Service, 1917–1919. With Mitten Management, Inc., Philadelphia, successively as stenographer, secretary to T. E. Mitten, Executive Secretary, and Vice President in charge of Public Relations. American Telephone and Telegraph Company, Information Department, 1930–1931. Chesapeake and Potomac Telephone Companies, General Information Manager, 1931–.

G. L. WELLER

The Chesapeake and Potomac Telephone Company of Baltimore City, 1901; Wire Chief, 1909–1912. Thereafter held the following positions with the telephone companies comprising the Chesapeake and Potomac group: Engineering Assistant, 1912–1917; Resident Equipment Engineer, Washington, 1917–1919; Equipment and Maintenance Engineer, 1919–1927; General Plant Maintenance Supervisor, 1927–1929; Equipment and Buildings Engineer, 1929–.

H. E. SHREEVE

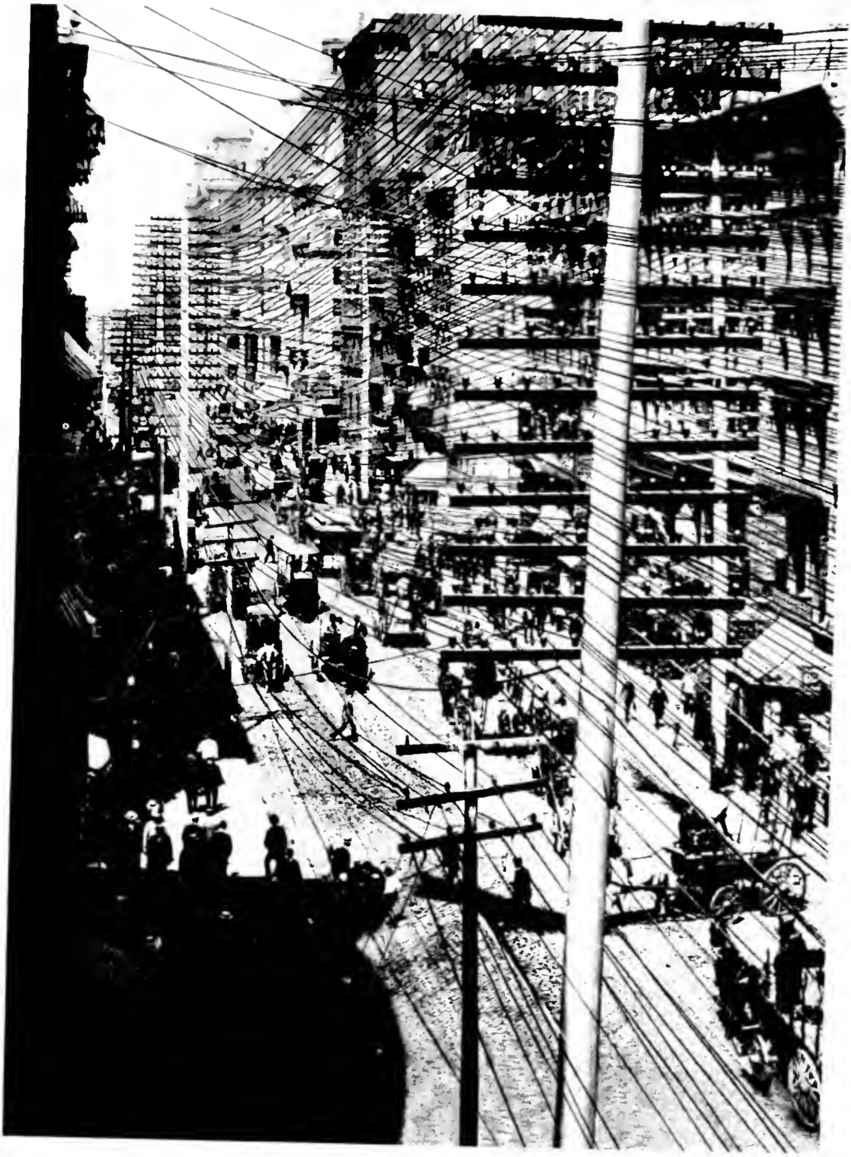
American Telephone and Telegraph Company, Engineering Department, 1895–1907. Western Electric Company, 1907–1923; Assistant to Vice President, 1923–1924. Bell Telephone Laboratories, Assistant to President, 1925–1926. In 1915 Mr. Shreve was in charge of the reception in Paris of experimental radio telephone messages from Arlington, Va. During the World War he served as Lieutenant Colonel in the Signal Corps. Since 1926 he has been Assistant to Vice President, American Telephone and Telegraph Company, and Technical Representative in Europe of the A. T. & T. Co. and Bell Telephone Laboratories.

H. S. OSBORNE

Massachusetts Institute of Technology, B.S., 1908, Eng.D., 1910. American Telephone and Telegraph Company, Engineering Department, 1910–1914; Assistant to Transmission and Protection Engineer, 1914–1920; Transmission Engineer, 1920–.

R. L. TOMBLEN

Bates College, B.A., 1914; Worcester Polytechnic Institute, B.S., 1917. American Telephone and Telegraph Company, Department of Operation and Engineering, Commercial Engineer's Division, 1919–1929; Chief Statistician's organization, 1929–.



Lower Broadway, New York City, in the '80s, Before Engineers Had Successfully Developed the Art of Placing Telephone Wires in Cables and Beneath the Surface. Some Poles Along Other Highways Were Ninety Feet High and Carried as Many as Fifty Cross Arms.

The Telephone Problem in the World's Largest Metropolitan Area

A Summary of Past and Present

MORE than a sixth of all the telephones in the nation-wide Bell System are concentrated in a section which composes only about 1/1200th of the land area of the continental United States.

This section, as defined by the United States Census Bureau, is the "New York-Northeastern New Jersey Metropolitan District," generally called the New York Metropolitan Area. It includes large sections of those two states and a small part of southwestern Connecticut, comprising a total of 2,514 square miles, a territory twice the size of Rhode Island. An exact circle enclosing such an area would have a diameter of about 57 miles. In its actual form, and using the Borough of Manhattan, New York City, as the center, the longest axis is approximately 95 miles and the shortest 40 miles.

Within this Area are approximately 300 incorporated communities. Among them, in addition to New York City with its five boroughs and population of 7,000,000, are Newark with about 450,000, Jersey City with more than 300,000, three other cities with well over 100,000, eight with over 50,000, fifteen with over 25,000, and more than a score with over 10,000.

The Area's aggregate resident population—10,901,424 according to the 1930 Census—exceeds that of any state except New York. Computed on the basis of that census, it contributes nearly an eleventh of the population of the entire United States.

This is the largest metropolitan territory on the globe: largest in geographical extent, in resident and working population, and in variety and volume of financial, industrial and commercial activities. It is a unit in a thousand and one matters of daily importance, not merely because of the relationships of each community with its nearest neighbors but chiefly because the ways in which people live and work within this Area are directly affected by the presence of the metropolis.

The commuting area, for example, coincides in large measure with the Metropolitan Area and in some sections extends beyond it. Many thousands travel regularly into New York City from points even thirty to forty miles away. Commuter traffic, entering and leaving the city by railroads and ferries, totaled over 268,000,000 in 1932. Including transient visitors and persons from the upper part of Manhattan, the number entering—by all forms of passenger transportation—the borough's chief business and financial sections south of 59th Street is estimated at around 2,800,000 each business day.

The retail trading area of New York City is even larger than the Metropolitan District as defined by the Census Bureau. So also is the New York Region as defined by the Regional Plan Association, a group of representative citizens who seek to help direct intelligent planning for the needs of the increasing population.

Within the Area is the Port of New York, whose waterways and 700 miles of waterfront not only produce a vast volume of ocean and river traffic but greatly complicate engineering problems in all phases of communication. The radial lines of eleven railroad companies and of numerous rapid transit systems reach into the central cluster of population from nearly every direction of the compass.

Manhattan, the heart of the Area, is a narrow island, twelve and one half miles long and only two and one half miles at its widest. In its narrow southern end, below Fulton Street, in a district of 245 acres, with 218 acres of building area, are concentrated, among many varieties of activity, the mechanism and personnel through which a large part of the world's financial and exchange trading activities clear. Thirty per cent of the borough's buildings above thirty-two stories in height are in this district, some ranging over forty, fifty or sixty stories in height.

Still another borough of the city, Richmond, is an island, as its popular name, Staten Island, indicates. Long Island, with two other city boroughs—one of them (Kings, or Brooklyn) the most populous of the five—and with a large suburban population, stretches 125 miles eastward from New York Harbor, separated from the mainland by a waterway narrow enough for bridges and tunnels only at its city end. Separating New York and New Jersey and also the suburban sections north of New York City is the Hudson River.

Nearly one-third of the people of the Metropolitan District are foreign-born, and about two-fifths are of foreign or mixed parentage. Together they compose over two-thirds of the Area's residents. Practically all races are represented, some of the groups being larger than the populations of the biggest cities in their lands of origin. There are sections where English is heard much less than some foreign vernacular.

These are among the many special characteristics of the Area which suggest the number and magnitude of the problems involved in serving its telephone needs. How has the telephone system for meeting these needs developed, and what are its general features and methods today?

Some High Points of Metropolitan Telephone History

When the telephone was "born," New York City, which was then confined as a municipality to Manhattan Island, had over a million inhabitants. In the metropolitan environs were almost twice as many more. In the next decade the Area's population was to increase by close to a million, and by more than that total in each of the succeeding four decades. Almost frantic efforts were being made to increase the means of physical transit. The Brooklyn Bridge, first of the great over-water highways here, was under construction. The city was having its first experiences with elevated steam railways. The demand for direct, personal communication was showing itself. Already, in 1874, a company had been formed to enable lawyers in Manhattan to telegraph to each other and to the courts.

On May 11, 1877, Alexander Graham Bell gave New York City its first telephone demonstration. Two lines of telegraph wire were borrowed for the occasion, one to Brooklyn and one to New Brunswick, N. J. A few months later, two business men of the city formed the Telephone Company of New York. Soon overwhelmed with difficulties, they were glad to sell out within a year to a group of which Theodore N. Vail, later to be head of the American Telephone and Telegraph Company, was a member. Mr. Vail and his associates organized the Bell Telephone Company of New York to operate in the area within thirty-three miles of the New York City Hall, together with outer Long Island and Monmouth County, New Jersey, the latter being the most southerly county in the territory. The 33-mile boundary, while determined on no particularly scientific basis, recognized the principle that the city and a wide region surrounding it were potentially a unit, and that any adequate telephone development must ultimately deal with the area as a whole.

After a settlement by which the integrity of the Bell patents was recognized by opposition interests operating in the city, the latters' plant and business were purchased by the Bell group, who reorganized in 1880 as the Metropolitan Telephone and Telegraph Company. A sub-licensee company, the Metropolitan District Telephone Company, was formed to handle territory adjacent to the city, and in a few years was operating through new or existing companies in several important sections and local points. Among these was Newark, which in 1878 had become the sixth city in the world to have telephone service.

Edwin Holmes, President. W. C. Humstone, Gen'l Supt.

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Meriden Brittannia Co	46 E 14th St
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Graioinger Wilman,	45 Broad St
Green Bros.	132 Pearl St
Hess I. & Co.	17 South St
Herold Emil,	25 William St
Hollister & Chamberlin	90 Broad St
" "	33d St & 11th Ave
Hoyt, Jesse & Co.	19 Sooth St
Javis & Co.	47 Broad St
" "	Clinton St., cor. Sooth
Lincolo, Geo. H.	90 Beaver St
Lehmao Bros.	40 Exchange Pl
Lord Chas. W.	7 State St
Macy's Josiah Sons,	189 & 191 Froot St
" " "	325 Water St
Moscord E. W.	2 State St
Meismer, Ackermann & Co.	45 Beaver St
Randolph, Edward F.	64 Pearl St
Both F. R. & S. D.	48 Exchange Pl
Sawyer, Wallace & Co.	47 Broad St
Van Emberg, & Atterbury,	33 New St
" " " "	180 Fifth Ave
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Bertreaux, CH. & Radou,	469 & 471 Broome St
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Cabot, Bowles & Co.	65 Beaver St
Cross & Beguelin,	21 Maideo Lane
Dreyfus, Kohn & Co.	35 Mercer St
Greeff & Co.	90, 92 & 94 Grand St
Halstead, Haines & Co.	378 Broadway
Hardt & Co.	473 & 475 Broome St
Hitchcock & Potter,	455 Broadway
Iseling, Neeser & Co	339 Canal St
Leisler & Sommerhoff,	85 & 87 Grand St
Luckemeyer, Kunoth & Co.	472 Broome St
Mills & Gibb,	408 & 410 Broadway
Nordlinger, H & Co	100 Pearl St
Oelbermann, E. & Co	57 to 63 Greene St
Passavant & Co.	222 & 224 Church St
Person A Harrimao & Co.	457 & 459 Broome St
S[illegible]mano, T & Co.	456 10th Ave

The First Telephone Directory in New York City, Issued in the Summer of 1878 with 271 Listings. Telephone Numbers Were Not Yet Used; Calls Were Made by Giving the Name of the Subscriber to the Operator.

This occupation of neighboring localities as well as New York City itself was exceedingly important in relation to subsequent events. From the beginning it was realized by those connected with the Bell enterprises that the nature of the service necessitated a unified system. Competition between two or more companies in any single center or homogeneous area would be costly to the public as well as to telephone enterprises, and would produce confusion of service, as was later proved at numerous points in this country.

In 1883 the New York and New Jersey Telephone Company was formed to operate in the counties of Northern New Jersey and Long Island. Its head, Charles F. Cutler, followed Mr. Vail as president of the Metropolitan company and later continued as the head of its successor, the New York Telephone Company. The latter, formed in 1896, also took over ultimately other properties in the Area and generally throughout the State of New York.

The continued growth in the populations and business activities in the metropolitan sectors of both New York and New Jersey, and the telephone development which both accompanied and helped to foster this growth, led in 1927 to a return to separate corporate leadership in each. The telephone property in Northern New Jersey was purchased by the Delaware and Atlantic Telegraph and Telephone Company, which operated in the southern part of the State, and the name of this corporation was changed to the New Jersey Bell Telephone Company. This step accorded with the desirability of a single company responsible for the service in each state and under the regulation of its respective state public service body, but operating—so far as service for the public of both states was concerned—as one system. As a further means of assuring close attention to the needs of localities, the territory served by the New York company is divided for administrative purposes into four areas, three of these—Manhattan, Long Island, and Bronx-Westchester—forming the metropolitan portion of

OFFICIAL PHOTO...

Parts of New Y..., and most complex telephone service area, wa... ...ent by the Army Air Corps in the ...re by permission of the

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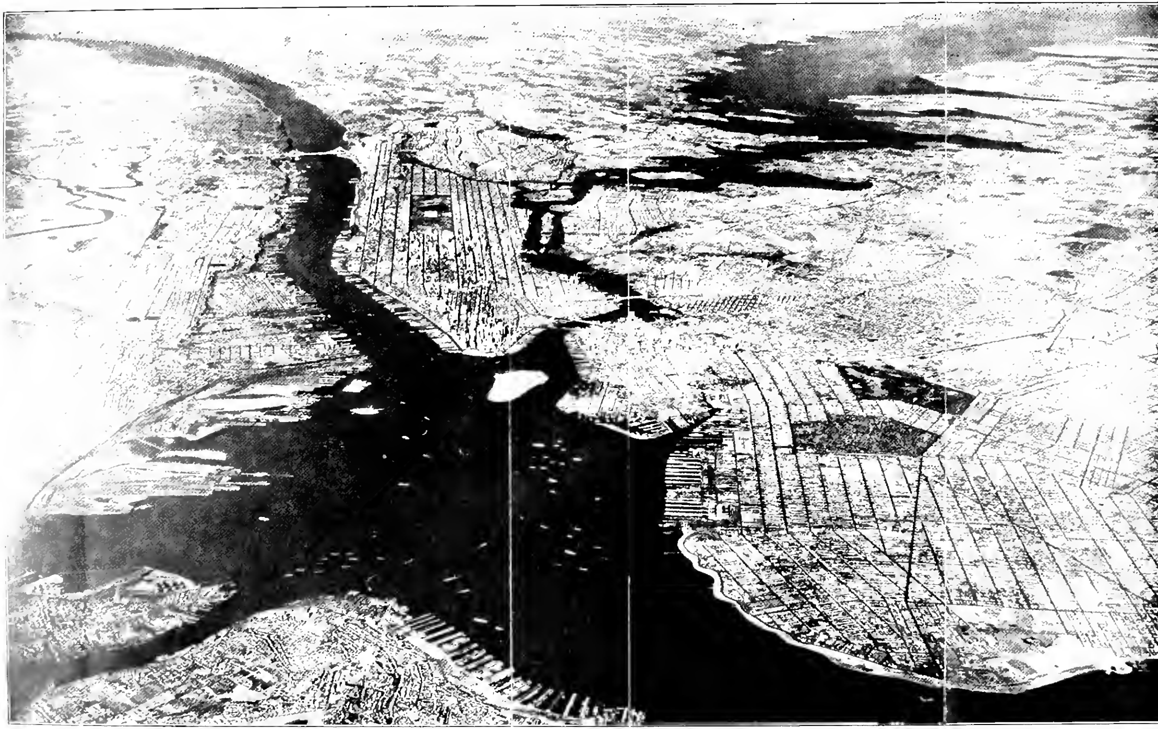
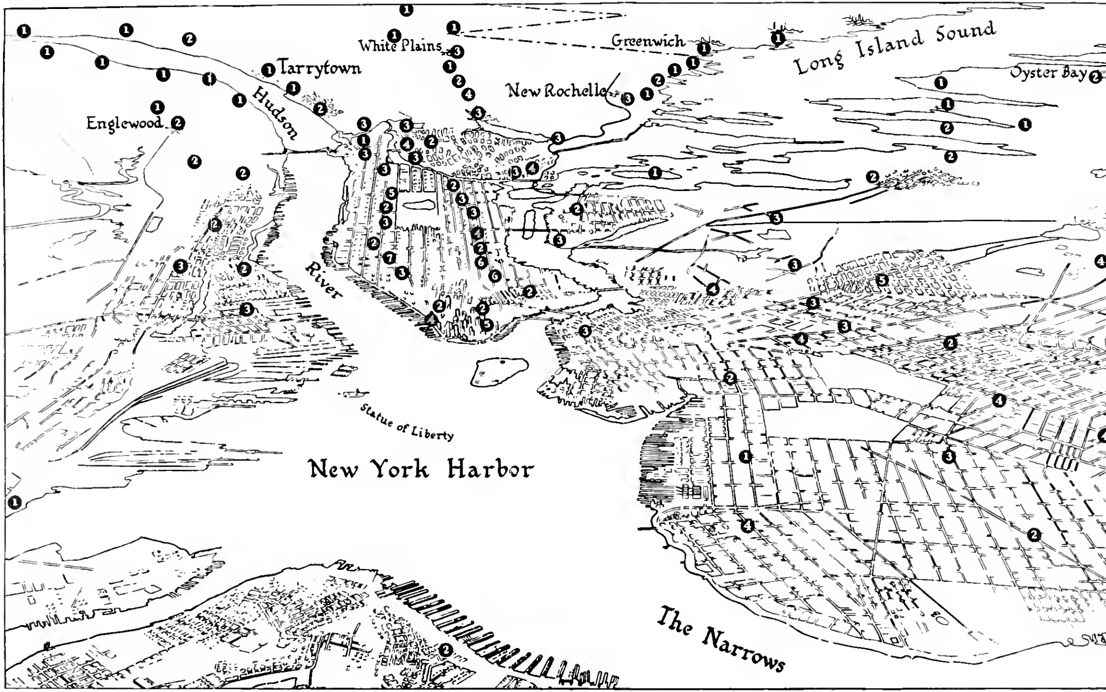


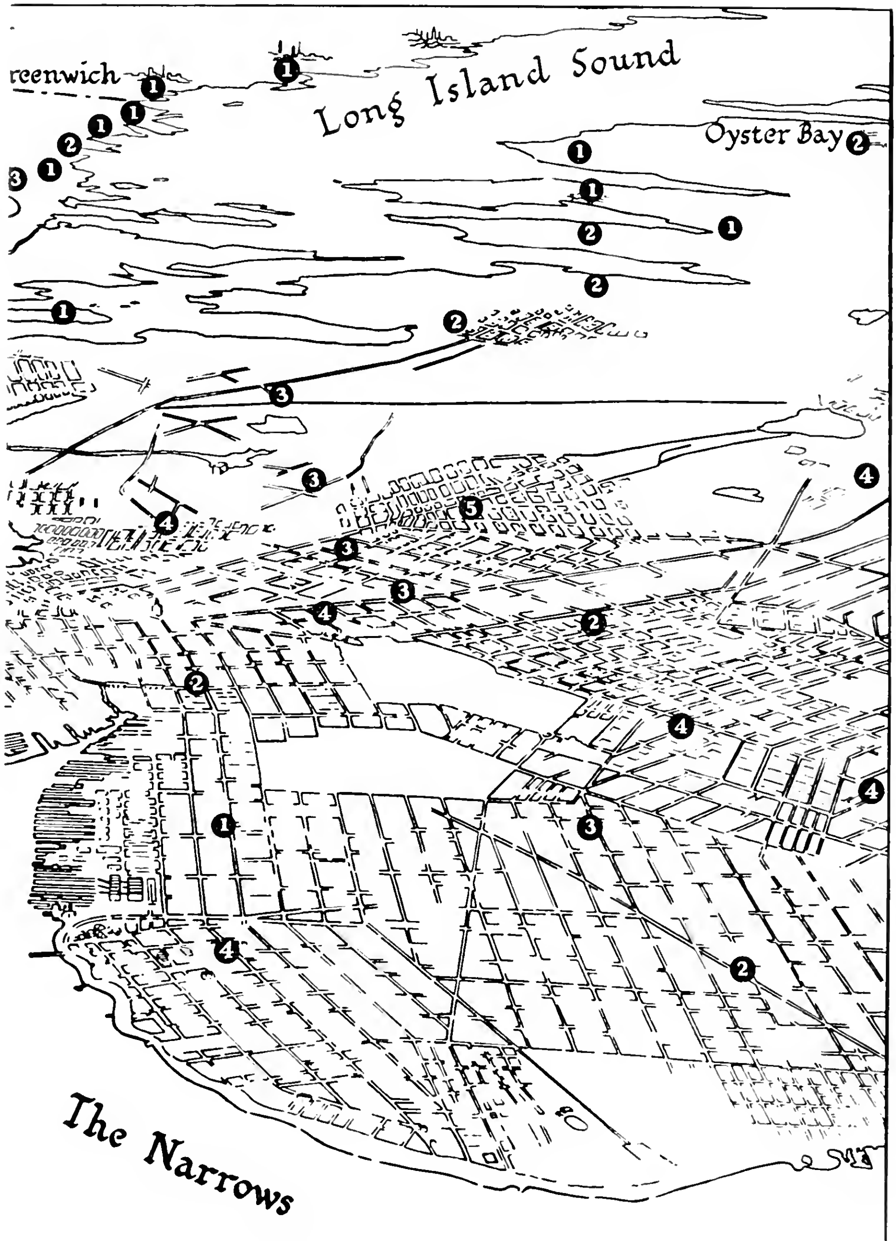
ONE OF THE MOST RECENT ACHIEVEMENTS IN THE FIELD OF AERIAL PHOTOGRAPHY

Part of New York City and Metropolitan New Jersey and their environs. This photograph, showing America's largest city, greatest population center, foremost port and most complex telephone service area, was taken by Capt. Albert W. Stevens at an altitude of 20,000 feet from an Army airplane piloted by Lieut. C. D. McAllister, and represents an achievement of the Army Air Corps in the development of aerial infra-red photography. It was originally published as a supplement to the National Geographic Magazine, and is reproduced here by permission of the Information Division of the Army Air Corps.



CENTRAL OFFICES IN PART OF NEW YORK CITY AND VICINITY

The black dots on this map, which follows in outline the aerial photograph on the reverse of this page, represent the 92 locations of central offices or groups of offices serving that part of the New York-New Jersey Metropolitan Area shown in the photograph. The numeral on each dot indicates the number of central office designations under which the telephones served from each point are grouped. The total of such designations shown here is 225. In the general metropolitan service area as a whole there are 378 central offices, serving approximately 2,255,000 telephones, under 478 designations.



< CITY AND VICINITY

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this company's territory. Each such area is thus served by what is practically a complete local organization.

The nation-wide development of Bell facilities and connections with the thousands of companies not in the associated Bell group and with systems in foreign lands has, of course, brought to every telephone user in the New York-New Jersey Metropolitan District the convenience of universal service.

Some Early Problems and Achievements

Throughout its early years the telephone business in New York City and vicinity was confronted by an increasing variety of almost overwhelming problems. Questions of financing and other difficulties intensified those problems which were directly related to the task of serving an increasing public demand: the problems of plant engineering, construction and improvement. In the late 'eighties, development was at an acute stage and scientific progress in outside plant construction, for example, was rapid. The older types of construction had become inadequate. The situation is vividly illustrated by the disastrous effects of the great blizzard of March, 1888, when the towering poles and heavy festoons of lines in the populous sections came down in a tremendous tangle.

For some time, the engineers of the major Bell companies and others had been actively working on the difficult problem of developing an efficient cable that could be used either overhead or underground. As early as 1879, four years before the opening of the Brooklyn Bridge for roadway traffic, the Metropolitan company had installed small cables over this structure. Over it in 1877 had been run a single circuit, the first means of voice communication between water-separated sections of the Area. In 1880 the company had four cables, each with seven conductors, across this span. In the same year a cable similar to these was drawn between New York and New Jersey under the Hudson River. By 1888 the standard cable was capable of accommodating fifty pairs of wires, but cost between $150 and $160 per pair-mile to install.

Shortly before the blizzard year, a more efficient and more economical method was discovered of insulating wires with paper and enclosing them in lead sheathing. It was a great step forward, for the modern telephone cable utilizes principles then evolved. But the practical application of improvements also takes time. Before the telephone people in New York, dealing with difficulties as to underground rights as well as engineering problems, could remedy the open-wire condition to any important extent, the Mayor ordered his Department of Public Works to chop down the poles. Fortunately for the telephone public as well as the company, this order was not carried out. Negotiations involving rights for building low-tension conduits were gradually cleared up, cable science continued to advance, and by 1895 practically all wires in the business sections were below ground.

Some Factors Which Fostered Growth

An inestimable factor for telephone progress in the Area was the sound financial position of the New York Telephone Company upon its formation in 1896. The Company was ready to do its full part in meeting and anticipating the Area's increasing requirements in a period of enormous business and residential development.

Another of the many factors which promoted growth was the matter of rates. Most people still looked upon the telephone as a luxury, and the rate levels that had been applied in these early days of the telephone were necessarily rather high and tended to result in a relatively slow growth. Few other than business people were subscribers. In 1893, fifteen years after the telephone had entered New York City, only about ten per cent of the business concerns had service. The charge for a business telephone (individual line, metallic circuit) in Manhattan was a flat rate of $240 a year.

At that time the number of telephones in the Metropolitan Area, among a population approaching 4,000,000, was probably only about 18,000. In what is now Greater New York, with a population then of over 2,500,000, there were only 14,000 telephones. When, shortly before this, President Cutler of the Metropolitan Company had issued orders that plant be constructed in expectation of 20,000 telephones in Manhattan and the adjoining Bronx County, he was regarded by some as visionary.

Telephone people were anxiously at work at the infant science of rate-making as well as that of forecasting plant requirements. The result was that, in 1894, they introduced in the city the message rate plan. Revolutionary at the time, it quickly proved itself in principle and practice as beneficial to both public and company under the conditions of the metropolitan area, and has been used ever since. The cost of a business telephone in Manhattan was cut to $120 a year for 700 messages. By 1899 it was down to $75 for 600 messages. Rates in other sections were also reduced.

A marked improvement of business took place in a comparatively short time. New York's telephones rose in six years to around 50,000, principally because of the increasing efficiency of the service, its larger value to users as the number of telephones grew, and the message rate system, which was particularly suitable to the area.

While there is some question whether New York City was the first center where this plan was instituted, its success here encouraged its adoption in other metropolitan communities. It solved on an equitable basis the peculiar problems resulting from the widely varying requirements of customers in such large centers. For example, some subscribers may make thousands of calls in the course of a year, or even a month, while others may make comparatively few, but all are entitled to a given number of local messages per month, with additional messages charged for as used. Thus the message rate plan, or measured service as it is also called, puts the charges for service more in line with the use made of it by each subscriber. In smaller communities, on the other hand, and in some neighborhoods or classes of service in populous centers, the service usage does not vary greatly, so that a flat or average monthly charge constitutes an equitable basis. Again, where a great number of telephones are concentrated, as in a big city, the cost of rendering service is greater, not only over all but per subscriber. In the telephone business, costs per telephone do not decrease but tend rather to increase with the number of telephones, although this tendency is retarded by continued effort toward economies through advancement of the art. In large cities the plant required is necessarily more complex as well as more extensive where the needs are greater, and the personnel to construct, maintain and operate it is larger. These costs are reflected in the higher monthly charge to the subscriber in the highly developed telephone center. At the same time, he has within his local calling area and vicinity so many of the persons he may wish to call or who may wish to reach him that the value of his service is enhanced. The more subscribers in the system locally or generally, the more valuable, of course, is the service to all.

Though rates have varied from time to time as changing economic conditions have affected costs, the underlying Bell System principle—of giving the best possible service for the least cost consistent with financial safety—has been steadily followed.

The War and Its Aftermath

In the quarter-century from the middle 'nineties to the close of the Great War, telephone growth in the Metropolitan Area was rapid. Previously it had not kept pace with the steady expansion of population. Now its rate of growth far exceeded the latter. The Area's inhabitants increased by two-thirds from 1900 to 1920; its telephones multiplied about fifteen times. Extensive improvements characterized every phase of the service throughout this period. In 1902 the first "loaded cable" was installed between New York and Newark. In 1915 long distance spanned the continent. Telephones in the Area were linked with a system that had become nationwide in scope.

During the War, telephone men and women and materials were required in the nation's service. Commercial telephone construction was under embargo for two years. Among the many thousands of employees who entered War service or related activities were large numbers of skilled and experienced workers from the telephone ranks. The personnel which remained—whether at the central office switchboards or in other departments—served the country's cause as truly as those in uniform, for with depleted numbers theirs was the task of trying to maintain a service which was not only essential to the public welfare but rapidly becoming more and more in demand through the War period.

With the end of the conflict, the telephone organization in the Metropolitan Area, as elsewhere, faced enormous and unprecedented problems. It had to overcome the effects of suspended development, replace the plant reserves used up during the War, recruit and train large numbers of additional employees, and build to meet the greatest demand for service in its history. And it had to do these things while handling a volume of telephone traffic vastly larger than ever before. New buildings, new switchboards, new relays, new distributing boards, new conduits, new cables, new pole lines, new facilities of every kind were needed in greater quantities than ever, and at a time when these things were demanded by every other section of the country. Raw and fabricated materials were difficult to obtain in sufficient quantities, and their cost rose rapidly.

Applications for telephones piled up by tens of thousands. At the peak of the demand, the unfilled applications totalled some 88,000 telephones in New York City, and in Northern New Jersey some 25,000, with additional thousands in other parts of the Area, bringing the aggregate into the neighborhood of 125,000. Telephone traffic in the Area increased by approximately a third from 1918 to 1921.

Inevitably, both during the War period and for some years following it, the quality of service was impaired. The company frankly stated its case to the public, and set itself to a task which is regarded as the greatest faced by every department of the industry in the history of telephony. Its accomplishment was the greatest achievement of its kind. The annual report of the company for 1922 contains these significant words:

> We have obtained the greatest amount of materials and equipment available and have built, assembled and added to our plant as fast as the maximum number of workers obtainable could rush it through and still maintain the standard of construction necessary for good service. This resulted in 1922 in additions to plant that exceed by far anything ever accomplished by any telephone company anywhere.

The cost of gross additions to plant in the Area, which had aggregated $18,000,000 in the year following the War, was double that total in 1920, reached $50,000,000 in 1921, and in 1924 exceeded $80,000,000. Orders for installations continued at a rate which, from 1919 through 1929, produced an average net growth of more than 140,000 telephones a year. A gain of nearly 180,000 in 1924 was approximated though not exceeded by the number added in the boom year 1929. During the period of catching up with the demand, a net total of around 1,000,000 new telephones had been added, so that in

1926 the 2,000,000 telephones in the Area were twice the number in service at the beginning of 1919.

In the space of a decade following the War the telephone plant in the Area was practically doubled in size. Moreover, the service was raised to new standards of convenience and efficiency—standards which were to reach even higher levels in succeeding years.

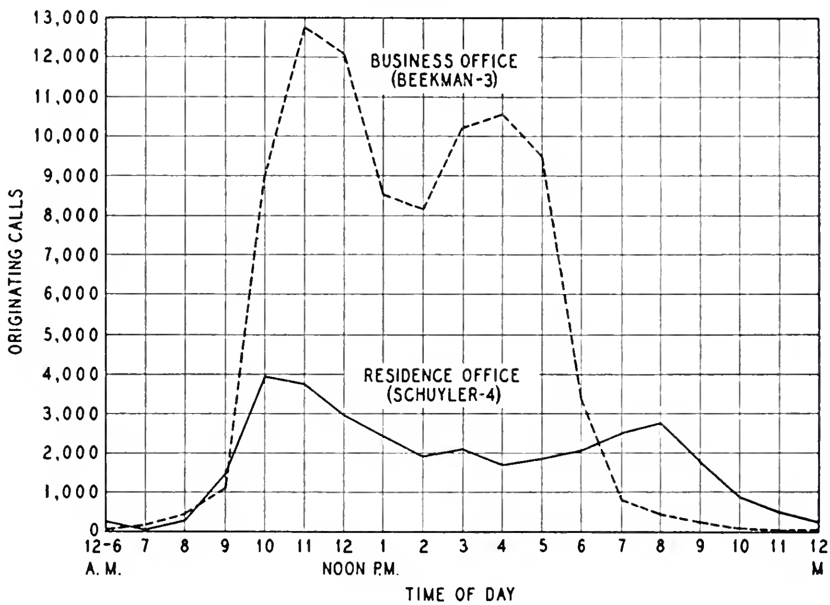
Serving the Myriad Needs of Today

Approximately a sixth of the average daily telephone conversations over the nation-wide Bell System originate from the telephones of this Area. Here is the world in cross-section, with the infinite variety of activities and relationships, needs and emotions, of an enormous and cosmopolitan population. All are portrayed in human speech, in the messages which flash daily, constantly, from telephone to telephone. To these instruments any voice is as important as any other.

The voice of the Area is never still. Thousands of calls are made even in the quietest hours of the night. Then, as during the day, operators are on duty at central office switchboards, and members of the plant forces are alert to forestall or correct troubles. Many of the troubles which might cause interruptions of service by day or night are discovered and remedied so promptly that telephone users are never aware of them. Thus during the hours when millions are sleeping the telephone is not only available for conversations but is, as always, the ally and guardian of private and public security.

As day approaches, telephones in the great wholesale markets assist in the distribution of provisions which housewives will be buying a few hours later from their neighborhood shops. Soon the new day's activities are reflected in the rising tide of calls. The commuting hosts converge upon the populous centers. Factories, stores and offices open their doors, followed soon by the banks and stock and commodity exchanges. In the residential and retail trading sections the telephone is helping in the day's marketing and shopping. In the various marts of industry and finance, at the railroad terminals, and at the docks and warehouses, the crescendo of telephone calls moves to its peak. Now, in greater measure than perhaps at any other time of the day, the Area is linked with the nation and the world in telephone conversations. With the afternoon,

HOURLY DISTRIBUTION OF TRAFFIC
WEEK DAYS
BUSINESS & RESIDENCE OFFICE
MANHATTAN AREA
JULY 1934



the social calls increase in the residential communities and neighborhoods, and as the business day wanes the calls between commuters in town and their homes and friends in the suburbs increase in volume. Again in the evening the calls rise in number as social plans and neighborly calls are made to points near and far. And woven through all the telephone traffic of day and night is the record of events here and elsewhere, as the world's news is assembled and prepared for millions of readers. Through it too run those golden threads which are messages of joy and encouragement, and those darker ones which tell of human suffering and urgent needs.

The Area's * telephones which serve these myriad requirements numbered, as of July 1, 1934, about 2,255,000, of which 1,478,000, or nearly two-thirds, were in New York City. Manhattan alone had about 817,000. The Area total compares with a record year-end figure of around 2,600,000 at the close of 1929. The residence telephones slightly exceed those used for business purposes.

The average daily telephone conversations during the first half of 1934 totaled approximately 9,183,000, or about 382,625 an hour. Toll calls averaged about 490,000 daily. The general total is well over twice the traffic of fifteen years ago. New York City contributed about three-fourths of the total. The city's calls, which in the first half of 1934 averaged around 80 calls per second throughout the day, have averaged in times of pronounced business activity as high as 100 calls per second. They far exceed this, of course, in the peak hours of the business day, especially between 10 and 11 A.M., when the traffic volume is from two to three times the hourly average.

Some 14,840,000 miles of wire provide the interconnections for these telephones and the facilities for linking them with the nation-wide system and with telephones abroad. Any one of them may reach or be reached by any one of 30,000,000 telephones in this and foreign countries, or 92 per cent of the world's total. The length of telephone wire serving the Area is nearly four times the mileage in 1918. It is equal to 5,778 times the air-line distance between New York City and San

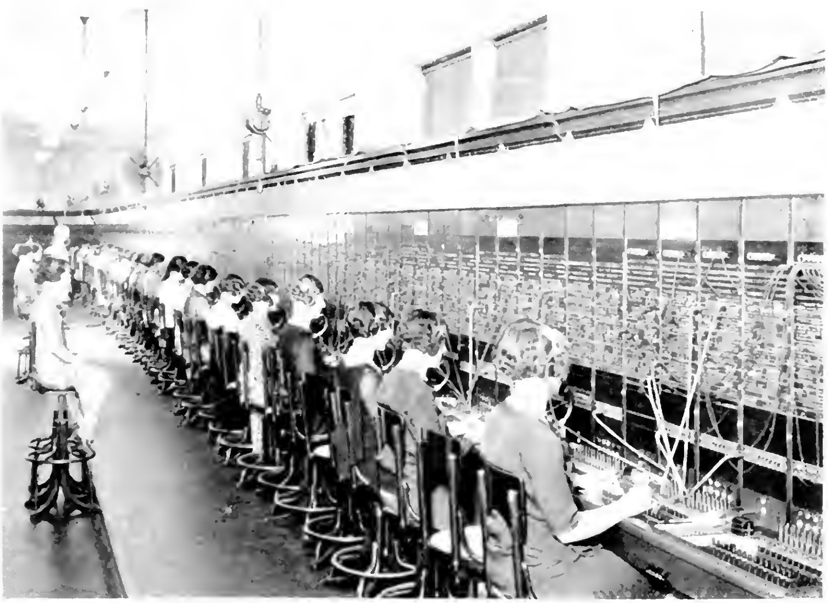
* As at various points the boundaries of the Metropolitan Census District, which is the territory mainly treated in this article, cut across telephone operating areas, it is not possible to give figures which conform precisely with that District. Some of the general figures given are, therefore, approximations, and as such are intended to give a reasonably accurate picture.

Francisco, and to nearly 600 times the distance around the earth at the equator. About 1,800,000 miles is for toll purposes. All but a fraction of one per cent of the aggregate is enclosed in protective cable, and 83 per cent is underground. In Manhattan, 98 per cent of the wire plant is below the surface.

Subscribers' telephones in the general metropolitan service area, which includes some sections not within the Metropolitan Census District, are grouped under 478 central office designations, and are served by 378 central offices, an addition of 138 since the War. New York City, with 160 central offices, has 192 designations in use, as many as the aggregate in the next three largest cities of the United States. The designations as a whole exceed those in the ten largest cities other than New York. The story of the Area's growth can be read not only in these totals but in the very character of the designations themselves. Their selection, to meet the requirements of such an Area, is as technical a task as many others in telephone engineering. Names used for such purposes are, where possible, those of the communities or neighborhoods served; but in a city or region served by many offices, each name must not only be easily read and easily spoken by telephone callers but must sound quite unlike any other used in that general section.

In addition, for dialing purposes, it is ordinarily necessary for each name of a central office within a given dialing area to have letters which provide a different combination of dial pulls from those of any other name within the areas. Thus, where there are many central offices and prospect of more, there is a limit to the suitable names which can be found. The method of designation used must meet the needs of future growth as well as present requirements. In New York City, this limit was approached several years ago. This problem has been met by giving the same name to one or more offices but adding for each office a distinguishing numeral—as, for

A New York City Central Office in the '80s, Showing "Beehive" as well as Early Desk Type Switchboards, and Both Young Women and Boy Operators



A Part of One of New York's Huge Manual Switchboards

Operators in Dial Central Offices Help in Handling Calls between Manual and Dial Telephones and to Points Out of Town

Instructing Student Central Office Operators at Practice Switchboards example, GRamercy 5 and GRamercy 7. When another office is established in the same neighborhood, it is practicable to use the same name but with another numeral. This plan also has the merit of permitting the wider use of neighborhood names or of names with which the public has already become familiar in telephone use. For example, in New Jersey, where it was introduced prior to its adoption in New York City, one of the main purposes was to retain the locality name in the central office designation for towns and cities having less than nine central offices. This would have been impossible without such a plan. From a manual telephone, the caller gives the name and numeral, followed by the line number, to the operator. From a dial telephone within the dialing area, the caller dials the first two letters of the name, as shown in capitals in the directory, the office numeral, and the line number.

In housing the various executive, commercial and operating activities of the Area's service, 204 owned buildings and leased quarters in 173 others are used. The former include the 32-story headquarters building of the New York Telephone Company, the largest telephone structure in the world and the administrative capital for the largest operating organization and most highly developed telephone territory; the 26-story long distance building, also in Manhattan and second in size only to the former; the 20-story headquarters of the New Jersey Bell Telephone Company, in Newark; and the 27-story Long Island administrative building, in Brooklyn.

The plant and equipment for furnishing service in the Area, comprised of land and buildings, rights of way, poles, wire, cable, underground conduit, switchboards, telephones, tools, and other items in use, represent an investment, as of January 1, 1934, of some $750,000,000, or about five times the total as of the end of 1918. While the figure reflects, in common with other industries, the higher costs of materials which persisted throughout the period of expansion after the War, it also illustrates the tendency of the costs of providing telephone facilities to increase faster than the number of telephones.

Employed within the Area in telephone service are approximately 48,000 men and women. They are so distributed among the various divisions and districts into which the Area is divided for administrative and operating purposes that each general locality is served by an organization completely equipped for the local needs and familiar with them. These telephone employees—in their number, in the character of their duties, and in their own economic and social relationships—have a vital and extensive part in the life of the communities in which they work and live and in that of the Area as a whole.

All employees who have completed specified terms of service are protected by a plan which, without cost to them, provides accident, sickness, pension and death benefits. Experience with this plan, instituted in 1913 throughout the Bell System, has shown its great value for both employees and the service, and therefore for the public. It gives the employee a sense of security which promotes interest and efficiency. It expresses the company's loyalty to the individual whose own loyalty to the service is shown by continued and conscientious effort. From the purely economic standpoint it helps to provide the company with a stabilized organization and thus to keep down the cost of rendering the service and of the rates charged to the public.

A majority—about sixty per cent—employed in the Area are women. About thirty-five per cent of the employees are related to plant work, and about thirty per cent are operators. The rest of the force comprise employees in the accounting, commercial, engineering and other departments.

Dial Service in the Metropolitan Area

About 1,210,500 telephones, or more than half of the Area's total, are served from dial central offices, of which there are 129. All but twelve of these, serving populous localities, are of the panel type. The others, in small New York communities, operate on the step-by-step method. About 69 per cent of New York City's telephones are now served on a dial basis. The Borough of Manhattan is 83 per cent on this basis.

The conditions which led to dial service in New York City are especially interesting. With the increased rapidity of telephone growth after the War, telephone engineers foresaw that it would soon be necessary to call upon automatic machinery to perform an increasing part of the task of furnishing service in the city. It had been clear for many years that it would be difficult and expensive to meet future demands for telephone connections and to continue to improve service relying entirely on manual operators.

The answer to these problems could be supplied only by the mechanical perfection and tireless operation of machine equipment. Under metropolitan area conditions, dial service is faster and more accurate than manual. Furthermore, with the dial there is less variation in the speed of connection, and, due to the fact that full operating facilities are available at all times, the dial service has a distinct advantage at night, on Sundays and at other times when manual switchboards must be operated with largely reduced forces. Dial service has become, therefore, a major factor in metropolitan service progress.*

The first installation of automatic equipment in the Area, made as early as 1914, in Newark, N. J., was of the semi-mechanical panel type, and was for the purpose of making a large-scale test of its efficiency. The first complete panel dial installation in the Area was made in Paterson, N. J., in 1922. Newark, with seven central offices, completed its conversion to

* See "Improvements in Telephone Service," by M. B. French, Bell Telephone Quarterly, January, 1933.

dial service in 1933. In 1922 a dial office was placed in operation in New York City as the beginning of its program of conversion. This office was "Pennsylvania," in a busy midtown section of Manhattan. The engineering and operation of this office were watched with extreme interest. One of the preparatory measures was the actual dialing of thousands of calls through the apparatus. Day after day sixty girls carried on this test. Several became so proficient as to dial over 300 calls an hour, indicating also the assured proficiency of the apparatus before it was cut into service.

The severest test of dial service was provided by the enormous stock market activities of 1928 and 1929, which increased telephone traffic in the Wall Street section to unprecedented volumes. It would have been humanly impossible for a manually operated switchboard to handle the nearly 200,000 originating calls, and the additional incoming calls, which were dispatched by the Hanover dial office in a single day. This full-size 10,000-line unit, one of three offices mainly serving the Wall Street district, became the busiest office in the world, establishing new high records for the number of completed calls.

The dial system is also regarded as providing special advantages in serving a cosmopolitan population. A caller's peculiarities of speech may readily cause mistakes and delays by human operators. However, even though unacquainted with English, he need only be able to "copy" a few letters and numbers on the telephone dial to make himself promptly intelligible to the apparatus.

Even with the dial system, there are requirements for large numbers of operating employees, for toll service, for special services, and other manual operations supplementing the dial. Telephone users who dial calls to manual telephones are connected with "call indicator" positions in manual offices, where the called number is displayed in illuminated figures. The connections are then completed by the manual method. Calls from manual offices to dial offices are completed at cordless boards—cordless because the operators complete the calls by depressing keys corresponding to the digits of the required line number. The more recent of these dial offices are so equipped that incoming calls are automatically distributed among the operators, thus expediting the service.

New York City, with its 299 square miles of area, its general north and south air line measurement of about thirty-three miles and general east and west breadth of twenty-five miles, is divided into fifteen zones for rate purposes. A subscriber's call within the city is charged as one, two, or three local messages, according to the zones involved. The maximum charge for a five-minute call between the most distant zones is equivalent to that for three local messages. With the majority of dial subscribers, calls made from their telephones to zones beyond the one-message range are made by dialing the operator and giving her the number. Their calls within the one-call range are counted entirely by mechanical message registers. In certain parts of the city from which a substantial portion of the calls are to points beyond this range, the lines of dial subscribers are equipped for the multiple mechanical registration of calls in connection with the direct dialing of calls to any telephone in any zone in the city. In Newark and the Oranges of New Jersey the multiple registration system, which was the first of its type in the country, includes all central offices with a calling range up to three units of charge.

Some Features of Toll and Long Distance Service

The efficiency of toll and long distance facilities in the Metropolitan Area is another of the great engineering achievements of modern telephony. Chief among the needs served are the constant flow of toll calls between New York City's numerous offices and those serving many hundreds of suburban points, and of long distance calls not only to and from the city but routed through this center to other distant points. All station-to-station calls to distant points throughout the country, whether within the area or beyond it, may be placed simply by giving the place and number to the local operator.

From any one central office the larger volumes of traffic to nearby places are routed over direct circuits, but for more distant offices and the smaller volumes of traffic the "Tandem" method is used. For this purpose, circuits connect these more distant offices with a central or tandem switching board, through which the calls between any two such offices are routed. Many small groups of traffic are thus combined for more efficient routing and handling. The tandem office, therefore, is practically a central office for central offices. Four such offices in the Metropolitan Area handle calls between New York City and outer suburban points, including many places beyond the Area's limits, and also calls between points in Northern New Jersey.

Located in Manhattan but serving a wide territory surrounding it are what are called Metropolitan Tandem, Suburban Tandem, and Long Distance Toll Tandem. The tandem office for Northern New Jersey, which is of the manual type, is located in Newark. The Metropolitan Tandem switchboard was the first panel type tandem board installed in the Bell System. It handles traffic between New York City and points within a radius of about twenty miles. While tandem operators are required to advance certain types of calls coming to this board, other calls are routed to the desired offices wholly by mechanical tandem equipment.

Suburban Tandem handles traffic chiefly between New York City and points over twenty and up to about sixty miles. Placed in service early in 1931 and superseding three manual tandem boards formerly handling calls to as many separate suburban sections, it represents the most modern and efficient type of tandem equipment. Its features include call announcer machines which automatically pass numbers orally to terminating manual operators in seventy suburban offices. These machines are a practical application of the "sound-on-film" principle to telephony, translating electrical pulses into audible numerals and letters in connection with the routing of calls via panel tandem switchboards. Other features of Suburban Tandem are the automatic distribution of incoming calls to tandem operators, and an automatic trouble-recording device by which mechanical difficulties occurring during the handling of calls by the automatic equipment are reported on a typewriter.

Long Distance Toll Tandem consists of two tandem switchboards of the manual type, located in the Long Distance Office and used for establishing connections from certain local and toll boards to toll lines outgoing from the New York Long Distance Office to various small offices.

The Long Distance Office itself is a battery of offices which compose the largest long distance center in the world. It is the focal point of many important cities in the United States and to points in Canada and Cuba. Through it flashes the traffic which is handled over the radio telephone circuits to Europe and other overseas points. It is the principal control point for the great radio broadcast chains. It houses the largest teletypewriter exchange. All private wires from New York to other cities, whether telephone, teletypewriter or telegraph, are brought through this building.

From the toll and long distance offices of the city a vast network of circuits fans out into the surrounding territory, for it is the regional center for a large section of the northeastern states. Crossing from Manhattan under its surrounding waterways are forty-six toll and long distance cables, with nearly 18,000 circuits. One of many notable engineering features is the permanent subway cable-crossing under the Harlem River, between Manhattan and Bronx boroughs. Through it pass not only the toll and long distance highways between New York City and New England points, and toll routes to northern suburban sections, but also the paths through which the greater part of the calls between the country at large and the north-eastern States are dispatched. This cable-crossing, completed in 1931, is a concrete-encased iron tunnel, 614 feet long and ranging in diameter from 7 feet to 8 feet 9 inches, and containing more than 200 cable ducts. Some of its parts are said to be the largest sections of iron pipe ever cast. It lies 27 feet below the average low-tide level of this busy water connection between the Hudson and East Rivers.

As a regional center, New York is one of eight strategic points throughout the country which, under plans already largely realized, will have direct long distance connections with every other such center. In addition there will be about 150 other cities designated as primary outlets, each of which will have direct connections with one or more of the regional centers. These outlets will serve as concentration points for calls going to the particular regional center, or beyond. Newark, for example, is such an outlet for Metropolitan New Jersey, with direct connections to Philadelphia, another primary outlet, as well as direct trunks to the New York regional center and to other points. Each of the approximately 2,500 toll centers in the United States will have direct connections with at least one primary outlet. By this plan anyone in the Metropolitan Area or anywhere else in the United States will be able to reach any other telephone, regardless of distance or remoteness, through four toll switches at the most. The facilities are such, however, that a large percentage of out-of-town calls are completed through only one switching connection.

Miscellaneous Aspects of the Service

Under normal conditions, two of New York City's large office buildings have as many telephones as the entire city had in the early 'nineties. In those days a single central office could serve a section which now, in downtown Manhattan below the City Hall, requires ten. One building in that section, at 120 Broadway, has had in banner years a population of between 11,000 and 12,000, and more than 6,600 telephones, with an average daily total of around 100,000 outgoing and incoming calls. To serve them required 2,560 trunk-line connections with central office switchboards, and riser and floor cables containing over 11,800,000 feet of wire.

The Empire State Building, the world's largest office structure, with 85 floors of rentable space above the street level and a population capacity of around 20,000, is at present equipped with nearly 31,000 feet of entrance, riser and floor cables, containing 18,555,000 feet of wire. The five 1,800-pair riser cables weigh 18 tons. Such figures indicate how important is the assistance of telephone engineers in so planning a large modern building that proper accommodations are provided for the equipment through which the telephones are to be served. The preparations also include, of course, scientific estimates of the building's telephone requirements, and the laying and connection of outside cable. Almost invariably, skyscraper structures are erected in crowded sections, where the underground plant is already extensive and complex.

To the engineering, construction and maintenance of the vast sub-surface plant are added the vital tasks of the shifting and replacement of facilities, without interruption of service, when public improvements are in progress, and their quick restoration in case of accident or disaster. The plant is so arranged that, in most cases when cables are destroyed by accident or fire, alternate routes can be quickly utilized. In major disasters, speed of restoration is, of course, all-important, and in this connection feats have been achieved which seem almost superhuman.

The most notable example, because of the scope of the disaster, was in 1927, when fire in subway construction burned off some 35,000 pairs of wires in 51 cables, contained in conduits and temporary supporting structures along the subway route. Twenty-one thousand were subscribers' lines, and 14,-000 were inter-office, toll and long distance lines. Identifying marks on cables were melted off in nearly all cases. Additional fires, coming after a good start in restoration work had been made, extended the range of trouble. Nevertheless, in approximately ninety hours after the first fire occurred, service was completely restored.

There are times when not great disasters but suddenly imposed needs bring an equal test of the emergency powers of the telephone organization. There was the time in 1933 when it seemed certain that the major facilities for securities trading would be moved from Wall Street to Newark. Within four days the New Jersey company placed a 12-duct subway for more than 700 feet, installed in the proposed new stock exchange building switchboards having five positions, wired nearly 400 hang-up handsets, and made preparations for furnishing hundreds of tie lines, foreign exchange trunks and private lines.

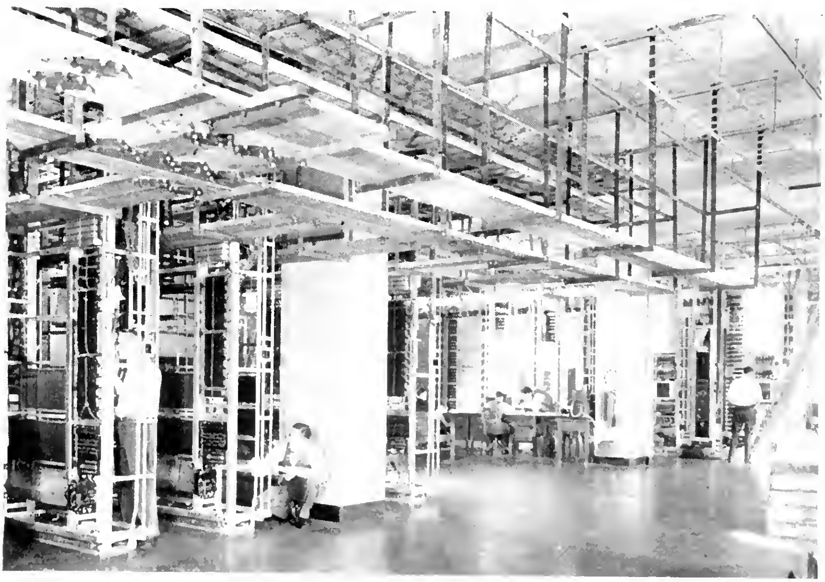
Private Branch Exchange Service

An exceedingly important element in the problem of rendering efficient service in the Metropolitan Area is the extensive use of private branch exchanges in offices, department stores, shops, plants, hotels, apartment houses, hospitals and other premises. Approximately 28,000 of these are in use by subscribers in the Area, the equipment ranging from small cordless or monitor boards up to manual cord boards and dial boards comparable in size with central offices serving small cities. This figure becomes the more impressive when it is noted that the total number of P.B.X. switchboards in service in the fifty largest cities of the United States is 81,000. The Borough of Manhattan alone has a fourth of the country's total. The office building at 120 Broadway has as many such switchboards as are in a typical city of 100,000 people.

A Training School in Manhattan for Private Branch Exchange Switchboard Attendants, One of Six in the Metropolitan Area

One of the Twenty-five Information Bureaus in the Area. Changes in Telephone Numbers Are Listed Here Promptly

One of the Seventeen Revenue Accounting Centers in the Metropolitan Area, Where Some 1,432,000 Subscribers' Bills Are Prepared Each Month



Expert Installation and Maintenance Make Possible the Precision Operation of Dial Equipment Twenty-four Hours of the Day

It is estimated that over half of the telephone calls in New York City and several other of the most populous localities in the Area either originate or terminate, or both, in these P.B.X. boards. In Manhattan, about seventy-five per cent of the calls come within this category. Hence the service rendered at these boards has a very large part in determining the quality of the service generally. There are approximately 35,000 attendants employed at such switchboards in the Area. In New York City they outnumber the central office operators by about three to one.

The telephone companies seek, therefore, to coöperate to the fullest extent in the training of attendants employed wholly or in part for P.B.X. operating by the various concerns and institutions. They conduct six schools in the Area—in Manhattan, Brooklyn, the Bronx, Newark, Jersey City, and Paterson—and encourage P.B.X. subscribers to take advantage of these opportunities for the instruction of attendants. Among the students of these schools from time to time, particularly in the one connected with the New York Telephone Company's chief P.B.X. bureau in Manhattan, are policemen who serve as attendants at the switchboards at Police Headquarters offices and in station houses. Between 400 and 500 members of the police force of New York City are assigned to these duties.

Placement bureaus are maintained in connection with each P.B.X. school. The bureau in Manhattan placed over 15,000 attendants from the beginning of 1929 to the middle of 1934, the annual totals ranging from 5,400 in the peak year 1929 to smaller figures in the subsequent periods. Forty per cent of the placements were in permanent positions. Many attendants obtain positions, of course, through other agencies. About 200 men and women devote their entire time to training, visiting, and other work incident to the efficient operation of these P.B.X. boards.

The largest manual P.B.X. used by a subscriber is in the Consolidated Gas Company's headquarters building in Manhattan, with forty-two switchboard positions and 231 central office trunks, serving at present about 2,500 extension telephones and 179 tie lines to various offices and plant premises. In busy times the traffic handled here, including interior communication service, has approached as high as 30,000 calls a day.

One of the largest dial P.B.X. boards serving a single subscriber is in the head office of the National City Bank in Wall Street. The machine equipment can handle service for about 2,500 extensions, from which local calls can also be placed without the aid of attendants. Associated with the head office are 75 branch offices, located throughout the Area, their 1,113 extensions served by smaller switchboards, which are also connected by tie lines with the headquarters switchboard. These tie lines and those to other affiliated offices number 100, and additional private lines extend to several of the largest cities. The headquarters P.B.X. has over 200 central office trunks. Incoming calls and outgoing toll and long distance calls are handled by attendants at twenty-two available positions.

Practically every large P.B.X. installation is especially engineered to meet the requirements peculiar to the customer. Such treatment is needed to such an extent that, in Manhattan, the engineering force required for this purpose is larger than the engineering organization in any one of many large cities for taking care of all central office and subscribers' facilities. A great hotel, for example, is a large community in itself, with a multitude of requirements to which the communication facilities must be so adapted as to assure the highest efficiency. Not only managers and guests but every department of operation, maintenance and service, and often a variety of shops within the premises, must be taken into consideration. Specially designed equipment will be found in each such establishment. The most extensive installations are illustrated by those in such hotels as the Waldorf-Astoria and the New Yorker, in Manhattan, each of whose private branch switchboards handle calls to and from several thousand extensions. Each has more than 100 trunks to the telephone company's central offices. In these also, as in many other hotels, teletypewriter systems are used for handling reports concerning the arrival, change and departure of guests, and for special message and paging purposes.

The facilities serving the offices and terminals of the railroad companies furnish further examples. The largest requirements in the Metropolitan Area are those of the New York Central Lines, whose New York Terminal District extends from mid-town Manhattan practically to the northern boundaries of the Area, and the Pennsylvania Railroad, whose New York Zone includes large sections of New Jersey and Long Island as well as of Manhattan. Both companies are served by specially designed P.B.X. equipment, the switchboards located at various strategic points being connected with a main switchboard in the administrative center. The consolidated railroad ticket offices throughout the city are connected by a network of tie lines with the reservation and information desks of the various railroad companies. Public telephone facilities in the Grand Central Terminal comprise 231 booths, 61 of which are attended, and for this purpose are distributed among five switchboards, served by 103 trunks to local and toll switchboards and nineteen direct lines to nearby suburban points. In the Pennsylvania Station are 206 public telephones, including 58 booths in three attended groups.

Among the unique examples of specially designed equipment is that which serves the New York Stock Exchange, where the facilities are such as to assure the highest possible speed and convenience in connection with the rapidity and complexity of securities trading. Changes in prices are telephoned by special clerks at the trading posts on the Stock Exchange floor to quotation attendants in adjacent premises in the Exchange building. Tie lines connect brokers' offices with the quotation desks. When information is desired as to the latest price of any listed stock or bond, the broker's office calls by special dial code the particular desk at which the records of quotations include the securities concerned in the inquiry. Orders to buy or sell are telephoned over tie lines from brokers' offices to their clerks in booths surrounding the Exchange floor, and the orders are then passed by messenger to the proper trading representatives on the Exchange floor.

Order receiving tables, or in some cases order receiving turrets, are another form of equipment in considerable use, mainly in large department stores and brokers' offices. All but a small number of these are in Manhattan, where the total is approximately 2,000. Attendants at these tables receive but do not make calls, which generally come to them through the P.B.X. on the premises. In many brokerage houses these tables receive calls wholly or in part over tie lines from affiliated offices in New York City and other cities. In the case of the large and most modern order receiving tables, the calls are distributed automatically to available receiving positions.

Directory and Information Service

All of the vast variety of engineering, industrial and commercial activities that go into the making of telephone service are directed towards one end: that whenever and wherever a person wishes to make a telephone call, he may do so with the utmost convenience, speed and satisfaction. An essential of this is comprehensive and quickly available information. To furnish it is one of the major tasks of the service, not only because of the extensive telephone usage and the great number of large and small localities served, but also because of the constant and extensive in-and-out movement of telephones and of changes from one address to another by subscribers. There are also the telephone number changes necessitated when, because of growth or service improvements, new central offices are opened or operating arrangements altered.

While the directories are issued at stated intervals, the work of compilation is a continuous task, the records of names, addresses and telephone numbers being kept up to date as the reports of new subscribers, changes, or disconnections flow daily into the directory offices. Employees engaged in compilation work in the Area totaled 365 as of July 1, 1934. New York City has five directories, one for each borough, because a general book would be too bulky for use. Manhattan's directory alone has over 400,000 listings and 1,000 pages, and Brooklyn 275,000 listings and 700 pages. As a whole they comprise over 4,800 pages of printed matter. In a recent new issue of these directories, nearly 1,650,000 copies were printed, and over 1,200,000 copies used for initial distribution—the task of delivery being a big one in itself.

Because of the many new, changed or discontinued listings from day to day, any telephone directory is in some degree out-of-date when it is issued. For the convenience of telephone users, therefore, these changes are made available promptly to Information Bureaus serving the localities involved. In both New York City and Northern New Jersey a printed record of each day's telephone installations, showing the names, addresses and numbers of new subscribers and of those who have moved, is furnished within twenty-four hours to each information operator. Every two weeks these daily records are recompiled in printed form for the use of the Information Bureaus.

Another important service is performed by the intercepting operators. When a telephone user calls a number which has been changed or discontinued, the call is passed to one of these operators, who asks "What number did you call, please?" and then gives the new number or explains that the telephone has been disconnected. She obtains her information from a numerical directory, which lists the telephones in the order of their numbers. Her records are kept up to date by daily records of changes and disconnections.

There are twenty-five Information Bureaus in the Area, served by nearly 1,400 operators and handling approximately 334,000 calls a day from points in and beyond the Area. The service in New York City is provided from eight bureaus, with an average of more than 244,000 calls daily; and in Metropolitan New Jersey from eleven bureaus, with an average of around 70,000 daily.

A problem of many years' standing in the city was the large volume of time-of-day inquiries. The old practice of asking the operator for the time became so common as to interfere with the efficient handling of regular calls. Through a succession of changes in the method of dealing with these requests, the present plan was developed, centralizing in one bureau, known as MEridian 7–1212, the time service not only for the city but for the larger communities in suburban Long Island and Westchester County, north of the city. Time announcements from this bureau, made at intervals of fifteen seconds throughout every hour of the day and night, can serve at present a maximum of over 900 simultaneous requests. Calls to the bureau from within the city averaged over 50,000 daily in the six months to July 1, 1934. Northern New Jersey also has a centralized time bureau.

The Task of Anticipating Service Needs

Despite the present enormous population of the Metropolitan Area and the unsettled economic conditions, the estimates of civic and business groups indicate that it is continuing to grow within its present limits and also to spread itself outward. New York City's population at present has been estimated at above seven and one-third millions, as compared with the Census Bureau's 1930 figure of somewhat under 7,000,000. The Regional Plan Association has suggested, as the result of exhaustive studies, a population in 1950 of more than 16,000,000 in an area taking in a territory somewhat larger than that included in the Census Bureau's definition of the Metropolitan District. Translated into terms of the latter's boundaries, the 1950 population would approximate 15,000,000.

However accurate these visions of the future may prove to be, the telephone requirements of the Area will continue to be exacting and complex and, in the long run, will presumably greatly increase. The telephone task is both to serve efficiently in the present and to prepare for whatever public requirements the future will bring. For this additional task it is necessary to try to look ahead, not merely for one or five years, but even twenty, twenty-five and thirty years. The great and changing metropolis, with its galaxy of greater and lesser communities, presents this problem in its most various and intensive aspects.

Here, as generally throughout the Bell System, surveys by telephone commercial engineers are the attempted horoscopes, as it were, of the conditions, population, family and business groups, and per capita telephone use of every community and locality. Every important change prospective in neighborhoods, public improvements, and transportation must be taken into consideration. Revision must be made as new factors appear and as added experience suggests new judgments. What these surveys show as to indicated requirements in each center and important neighborhood are the basis upon which is built up the fundamental plan—the broad lines of change and growth along which the telephone structure must be built. For the formulation of this plan, studies must be made of various schemes of providing service, estimates drawn up of the cost and annual charges for land, buildings, switchboards, cables, and underground conduits, and computations made of operating expenses, having in mind in all of these the principles both of economy and of even higher standards of efficiency than in the past.

In this work, as in its current service, the policy and purpose of the telephone organization is identical with the interests of telephone users and the general community: that is, service which shall always be in pace with and indeed ahead of the needs, service which shall always be as low in cost as is consistent with efficiency and with the financial integrity of the company whose responsibility it is to render it, service which shall be useful and progressive in the fullest meaning of these words.

KIRTLAND A. WILSON

Buying by Telephone at Department Stores

WHEN a commercial kitchen in Chicago is moved to undertake an extensive advertising campaign urging housewives to telephone for hot meats to be delivered in forty minutes, one might be justified in assuming that the telephone has reached the zenith of public acceptance as a buying medium. But the assumption would fall short of the truth, as hasty conclusions are so likely to do. The fact is that, although home telephone development in American cities ranges generally between 30 per cent and 60 per cent, probably not more than 5 per cent of the merchandise supplied to these homes by large downtown department stores is ordered by telephone. Considerable recent study has been inspired by this seeming discrepancy, and this article is an attempt to summarize the findings.

The most casual observation makes it clear that there is no well-defined opinion among department store executives as to the place of the telephone in the moving of goods from their shelves to their customers' homes. Present policy runs the entire gamut from definite discouragement of telephone shopping to enthusiastic cultivation of the telephone market, with the general mean resting in a zone of indifference based largely on a lack of specific knowledge.

When observed through the same merchandising lens by which the department stores view their own markets, it is not to be wondered at that telephone commercial people are looking with interest at this market for prospective telephone business. There are in the United States about 4,000 department stores. These handle somewhere in the neighborhood of a billion orders in a normal year. Every hundred orders involve a great many other contacts between store and customer. There are inquiries about material for sale. There are matters of adjustment of bills and questions about deliveries. Certainly not less than a billion and a half communications transactions are involved—the very stuff of which telephone volume is made.

The question which must govern our deliberations is simply this: Why do not more people use their telephones in dealing with the department stores that serve them? It is not because telephones are not available to them, for a telephone is always closer to the buyer than is the store itself. It is not because the stores lack delivery facilities, for their trucks ply the streets of all our cities on regular daily schedules. And, strange as it may seem, it is not because the shoppers are reluctant to buy by telephone, for such surveys as we have made among the shoppers themselves, as later discussed, indicate a preference for the telephone method much wider than the use made of it.

We have found within the department stores themselves a large number of factors contributing to the present situation. These may be roughly summed up in four major reasons, an understanding of which brings us closer to the answer to our question.

1. Department stores are now organized to handle counter sales, with telephone sales a by-product rather than an objective.

It is one of the oldest tenets of merchandising that a face-to-face contact between buyer and seller contributes to the consummation of the sale. This is no less fundamental today than it was a thousand years ago. It explains why merchants—Babylonian, Egyptian and Roman, as well as American—have always used all their ingenuity to induce people to come to their counters. It explains the alluring counter displays, special entertainment attractions, restaurants and the thousand other devices which are the day-by-day stock-in-trade of every large modern department store. It explains the underpricing of advertised articles, the so-called "loss-leader" practice, ages old but now fallen into disrepute.

This passion to "get them in" has so long guided the minds of department store executives that it is not surprising to find many of them looking askance at plans to encourage telephone shopping, fearing that it might have the effect of keeping customers from the store. Studies made coöperatively between stores and telephone companies have seemed to indicate that telephone shopping does not keep shoppers from buying at their favorite store. What it seems actually to do is to enable them to buy at their preferred store when conditions do not permit them to visit the store in person. The store therefore gets business which it might otherwise lose. Whatever the fact may be, until a great deal more is known on the subject we are likely to find the telephone shopping bureaus continuing to be looked upon as "service" features rather than as profit-making departments to be fostered and promoted.

2. Stores are often lacking in adequate telephone equipment and in trained telephone personnel.

People who use their home telephones for shopping frequently have such unfortunate experiences in wrong material received, missed deliveries, or failure to get a prompt response from the proper department, that they abandon this method and make personal visits to the store (or to another store). This is because the telephone business is not given the same kind of attention as counter business. The truth is that the handling of telephone business is not something that can be done in casual fashion, but must be organized and planned for with all the care that characterizes a successful mail-order business.

3. Telephone orders are supposed to have a stimulating effect on "returned goods."

The acceptance of returned goods is a problem always uppermost in the merchant's mind. He looks upon it as a nuisance item having a bad effect on his operating costs and cutting down his profit margin. Some merchants with whom we have discussed the matter have been of the opinion that the expansion of telephone business tends to increase returns because the article is purchased sight unseen.

Those who have taken pains to trace returns back to the original orders have generally found that telephone orders have fewer returns than counter purchases. One store that for years had discouraged telephone business for this reason agreed to make a comprehensive study of its telephone business, but eliminated the returned goods question as an element in the study because its executives were willing to concede, *without figures*, that they had been mistaken in their view. "We have asked several stores to verify this," says the *Retail Ledger*, "and usually they are surprised to find after a test that returns from phone orders are below the average, provided the calls are handled intelligently."

In spite of these rather clear indications, the present state of the merchandising mind on this point stands in the way of more aggressive cultivation of the telephone market, and is likely to continue to do so until more stores find it advisable to establish the facts by actual reference to their own records.

4. Store advertising frequently falls short in its appeal to the telephone market.

It is not enough to have adequate telephone facilities and trained personnel. The shopping public must know that the store has them. There is only one known way to get this news abroad, and that is by the same channel that the store uses in telling of the goods it has to sell: the channel of its regular advertising. It would seem unnecessary to state this obvious fact were it not for the large number of stores that welcome telephone business but assume a telephone consciousness on the part of the buying public that is more apparent than real, and consequently fail to advertise their telephone services.

Department stores that have devoted part of their regular space to an adequate appeal to the telephone market have found an immediate upturn in orders received. In one case actually studied, telephone orders were multiplied four times within a few months by the simple expedient of adapting the standard store signature to include its telephone number.

Adequate advertising is especially necessary to build up telephone trade in communities where the stores have previously been indifferent to it, with the result that the telephone shopping habit has not kept pace with the growth of the telephone habit generally and of the facilities available for the use of shoppers.[1]

These are by no means all the elements in the problem but they are sufficient for the present discussion.

Some study has been given in both department store and telephone quarters to reducing the present maze of guesswork and inhibition to the realm of factual data. We present the findings of one such survey, made coöperatively with a large department store in a city of the first class. The random sample of 491 orders used in this study is perhaps too small to justify a final conclusion, even in the case of this one store. But we believe the findings are indicative of the results that may be generally expected under similar conditions. The name of the store is withheld at its own request because of the intimate nature of some of the data, but we are indebted to the management for permission to use the material anonymously.

Study of 491 Telephone Orders

This store, in the spring of 1933, installed an up-to-date shopping bureau, with equipment suited to its needs and a specially trained sales group to answer calls. All shopping calls came directly to this bureau through a special number distinct from the store's regular number. For some months the bureau and its telephone number had been referred to in the store's regular advertising, resulting in a steady increase in incoming calls and a consequent increase in equipment and

[1] This subject was more fully discussed in an article "The Telephone's Place in Coöperative Advertising" in the April, 1933, Bell Telephone Quarterly.

in personnel. From this point of view the plan was fully successful, but certain of the store's executives were not satisfied that it was an economical method of selling. Nor was the telephone company fully convinced as to the extent to which it could economically go in aiding the store in its plans to promote telephone shopping.

Examination was accordingly made of 491 telephone orders selected at random from those received in the shopping bureau between March 7 and March 27, 1934, so as to determine:

1. The profit accruing to the store from its telephone business.
2. The effect that telephone business has on various phases of store operation.
3. The revenue influence of this business to the telephone company.

Two employees with appropriate telephone equipment were assigned to observe these orders and make adequate records on special forms. The articles ordered, the amount of sale, whether the article was advertised, charge or C.O.D., suggestive selling data, remarks of customers as to reasons for calling, the state of the weather, and every other item that might have a possible bearing on the problem, were recorded.

After the information had been carefully tabulated and analyzed, a complete report[2] was prepared, of which the following is a brief summarization.

1. The annual profit on the merchandise included in these orders appeared to be at the rate of 33.2 per cent on the store's stock investment, which compared favorably with the results for the store as a whole.

2. It appeared that the availability of telephone service tended to increase the total business done by the store. Many of the customers testified that they would have been unable to make the purchase from the store except by telephone. It

[2] It is obviously impractical to reproduce this report in full, but a copy will be sent to any reader who is interested in the methods of the study or the detailed results, on application either to the author or to the editor.

would also seem that the telephone did not tend to keep people from the store, since 76 per cent of the charge customers ordering by telephone also made personal visits to the store during the study period. There is a wide diversity in the type of merchandise ordered.

3. A study of the locations of customer's telephones, and reference to the message and toll records of the telephone company, indicated that these 491 telephone calls included 210 additional local messages, pay station calls and toll calls, having a total revenue value of $9.70. The additional measurable telephone revenue from these 491 calls therefore averages nearly two cents per call. This is exclusive of the revenue influence of the remaining 281 calls and the indeterminate number of other calls that these 491 calls stimulated in the nature of call-backs from the store, inquiries about deliveries, etc. Indications are therefore that every thousand incoming calls to this store have an additional measurable revenue value to the telephone company of nearly $20.

Effect of Telephone Orders on Store Profit

The following profit-and-loss summary shows in somewhat greater detail the relation of various items of expense to one another and to total sales in the case of these 491 orders:

1. Mark-up of Merchandise Sold (Sales price over actual cost)		36.4%
2. Direct Expenses		
A. Labor—Salaries at Order Board	0.9%	
B. Supervision—Portion of Adjustment Manager's Salary	0.2%	
C. Wrapping and Delivery	3.0%	
Total	4.1%	
3. Fixed Expenses		
A. Order Board Equipment—Used for Sales	1.0%	
B. Overhead	21.0%	
C. Stock Shortage	2.0%	
Total	24.0%	
4. Total Expenses		28.1%
5. Net Profit to Sales (Item 1 minus Item 4)		8.3%
6. Annual Profit to Stock Investment (based on a complete turnover four times a year)		33.2%

The question may well be asked: Can a study involving so small a group of orders in one store be considered as typical? It would be hazardous to make such an assumption. Yet there seems little doubt that if a more thoroughly organized shopping bureau had been used, one with a larger volume of business and a better trained force, the results would have been still more indicative of the profit-making possibilities of telephone merchandising.

Conditions and methods differ so considerably in different stores that what may be true of one may not be true of another. It may be of interest, however, to attempt a summary of the opinions of store managers as to how telephone orders affect some of the items of department store expense.

Personnel

There is general agreement that telephone clerks can handle more orders than counter clerks. While the exact ratio is not easy to determine, some managers have stated that as many as three telephone orders can be received in the time required to handle two at the counter.

Supervision of telephone clerks is generally considered to be more simple. There is the further possibility of economy by the shifting of telephone clerks to counter and other duties, since the telephone order peaks do not correspond with the personal shopping peaks of the store. Three-fourths of all telephone orders, for example, seem to be handled before noon in most stores, and one store testified that 80 per cent of its telephone business came between 9.30 and 10.30.

Returned Goods

We have already mentioned this important expense element. It is enough here to say that only one department store among the many with whom this matter has been discussed, with actual figures available, has found returned goods from telephone orders to be higher than from counter orders. The difference in this one case was only 1.5 per cent and seemed to

Figure 1. The Telephone Order Department of Marshall Field and Company, Chicago

Figure 2. Kann's Telephone Order Department, Washington, D. C.

Figure 3. Hutzler's Telephone Order Department, Baltimore, Md.

be due to the great emphasis placed on suggestive selling in the telephone order department. In all other cases returned goods from telephone orders were lower. The reason generally given is that people either have made up their minds about the purchase before they telephone, or they are ordering standard or packaged material. Furthermore, there is the tendency of shoppers to visit the counters to compare the merchandise of various stores before buying, making the final sale either by a second visit or by telephone.

It is safe to conclude that in most stores returned goods expense should be lower on telephone orders than on counter orders.

Delivery Expense

This is an important item, for about 38 per cent of all merchandise bought in department stores is now delivered and the trend is increasingly toward more deliveries. Since all telephone orders call for delivery, there is natural concern on this point, and it naturally resolves itself into a question of whether the store does or does not wish to sell merchandise that must be delivered. Usually the delivery systems are already so well organized that, except in peak times, any increase in telephone orders is just as likely to provide the load that makes the delivery profitable as to force an increase in this item of expense.

There is some fear that the telephone encourages hand-to-mouth buying, making for small purchases and consequently high delivery costs. Our studies indicate that, where the telephone bureau is adequately developed, there is little ground for this fear. Telephone sales amounting to several hundred dollars per item are on record. The following table of a few items selected at random is furnished us by a large New York store and indicates what we believe to be true: that the size of telephone orders compares favorably with that of counter orders and in some cases is greater

Item	Average Telephone Order	Average Counter Order
Drugs	$1.40	$1.18
Towels	No Difference	
Sheets and Pillowcases	5.30	3.75
Women's Cotton Underwear	No Difference	
Smocks and Aprons	2.05	2.35
House Furnishings	1.86	2.20

In the study of 491 orders discussed above, it was significant that many of the customers called from telephones reasonably close to the store. The proportion that came from the suburban area—about ten per cent—did not greatly exceed the proportion that came from business telephones in the downtown area. There is enough evidence, even in this small sample, to indicate that it would be unwise for a store manager to form a conclusion on this point without a specific study of the telephone orders being handled by his own store.

Telephone Expense

Consideration must also be given to the cost of telephone equipment to handle any increased volume of telephone business. Experience indicates that this expense is more than offset by the advantages that flow to the store in other directions. One large store whose annual expense for telephone equipment alone amounts to about $175,000 considers this an investment of indispensable value to the store. Nor is this surprising, for its annual gross sales by telephone amount to about $5,000,000.

Credit Expense

There is a feeling, particularly among the smaller stores, that an expansion of telephone business tends to increase the extension of credit. No indicative figures are so far available on this point, but it is significant that none of the larger stores that have had wide experience with telephone merchandising seem to be apprehensive of the effect of telephone business on their credit situation.

Equipment and Personnel

The importance of this subject may be deduced from a study made in ten department stores of a large city. Variations were found of from 18 to 47 seconds in reaching the store switchboards, 22 to 46 seconds in getting the proper department, and 18 to 80 seconds in getting the proper sales person. In other words, as much as three minutes might be consumed in establishing contact between the customer and the store employee able to handle the order intelligently. The first objective of a store in considering improvement in telephone order handling is to get this initial time down to a minimum, and this is a matter of adequate equipment and adequate personnel.

The telephone equipment that is used by department stores and the methods of handling telephone order business are almost as varied as the opinions that prevail among department store executives concerning telephone shopping. In a general way, they may be set apart in three classifications.

1. Telephone orders handled at counters

Many stores, in the matter of telephone layout, have not progressed beyond the simple method used in the first decade of telephone history. The customer's call is received by the operator at the store's regular switchboard. She determines the department selling the article desired, and switches the call to that department. The call is answered by one of the salespeople at the counter, who frequently has to leave another customer to take the call. The telephone customer repeats the order. The sales-person frequently does not know the department's merchandise at other counters and the call may again have to be switched, or another sales-person called to the telephone. In either case the order is repeated for the third time.

The confusion that results from this out-moded method is too obvious to require elaboration. It is particularly unsatisfactory from the point of view of the telephone customer because of the waiting and transfers involved with this method. Furthermore, counter customers are annoyed and inconvenienced by the clerk's attention to the telephone call. Perhaps the prevalence of this method is one of the reasons why the telephone shopping habit runs so far behind the telephone shopping inclination as developed in our surveys.

2. Shopping bureau connected with store's switchboard

At certain other stores the incoming calls from customers are switched to a special board. Boards of this type were first developed chiefly to handle adjustments, but the taking of orders is assuming even greater importance. At this board sit special operators who are able to accept the orders and forward them for attention to the proper departments. The equipment is frequently so constructed that if necessary the operator, or perhaps we should call her the telephone sales-clerk, can talk to any of the departments of the store while the customer holds the line. In this way she not only becomes expert in the technique of receiving telephone inquiries and orders, but quickly learns the proper channels of information in each department. The customer's wishes are fulfilled, with a minimum of delay and annoyance.

The equipment used in these shopping bureaus is usually in the form of a series of order turrets not unlike the positions on the common switchboard. Another development, particularly suitable for small and medium sized stores, consists of what is known in telephone parlance as "key equipment," whereby the calls are handled by means of switches on a flat-top table rather than by means of cords and plugs. Typical department store installations are illustrated in Figures 1, 2, and 3.

3. Shopping bureau with direct lines to central office

This method is a still later development of the separate shopping bureau. The equipment is similar to that described above, but it is connected directly to the telephone company's central office and is assigned a telephone number entirely independent of the regular number of the store. One store has a separate number for charge customers alone. By proper directory listing and adequate advertising, the store's customers learn to use this number, with the result that their calls are answered by the order-taker without the delay entailed in going through the store's operators. The lines can also be held while the operator-sales-clerk converses with any department, if that is desired, although the largest stores find about 95 per cent

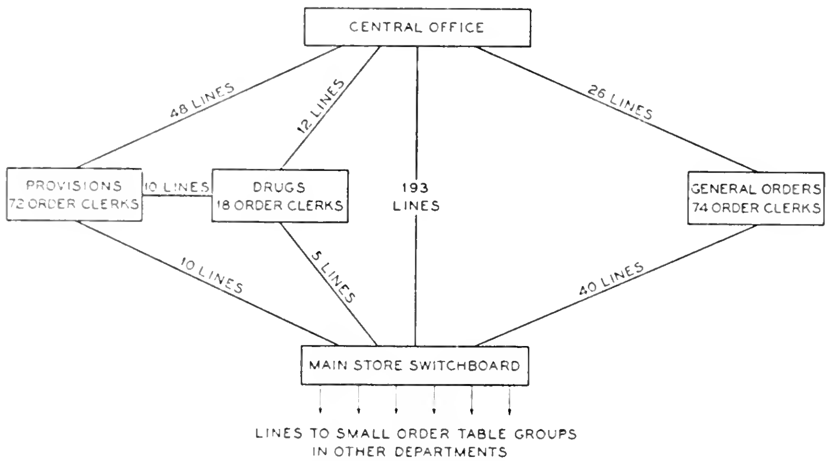


Fig. 4. A Diagram Illustrating How Telephone Orders Are Handled in One Large Department Store. It Is Not Unusual for This Store to Handle as Many as 50,000 Telephone Transactions in One Day.

of all telephone orders handled without reference to any other department. By this means the customer has only one contact with the store, yet if direct conversation with a department is desired, it can at once be provided.

In such a telephone shopping bureau as this, sales people are selected from the trained personnel of the store because of their courtesy, the quality of their voices and their mental fitness to learn the essential details of the store's policies and merchandise. They have before them the current advertising of the store. Samples of the merchandise for which the largest num-

Fig. 5. An Example of a Department Store Full Page Advertisement Built Entirely Around the Telephone Shopping Appeal. Such Advertising Is Not Infrequent Among Telephone Merchandisers. The Use of Expensive Newspaper Space to Encourage Telephone Purchases Is One Measure of the Value of This Type of Business.

ber of orders are anticipated are also nearby, so that if necessary they can describe the details to the customer. Department heads frequently instruct this sales group in the fine points of the merchandise.

It should be emphasized that, while these general terms may be used to describe what is being done in the better-equipped stores, there is no such thing as an "approved" or "best" method that can be applied to all. The best telephone shopping bureaus have developed through the years with characteristics peculiar to the store, its personnel and its problems. A telephone order department does not spring into being overnight. It is not a ready-made but a custom-made article.

For example, a variation of the central bureau method is found in one of the very largest of the telephone order departments. Individual order tables are located in several departments and calls may be routed to them from the main store private branch exchange. Some of these departments handle enough orders to justify direct lines to the central office and separate telephone numbers, so that a customer desiring to order groceries, or drugs, for example, can call the number of that department just as though it were a separate store.

The advantage of such a telephone set-up to the customer who wants to do business by telephone is obvious, and stores using this method may be expected to secure and hold the patronage of the telephone-minded customers.

It is just such a highly organized and efficient telephone shopping bureau that enabled Abraham & Straus of Brooklyn, N. Y., to say in its newspaper advertising of July 1, 1934:

> It's going to be one of this summer's most exciting indoor sports—calling CUmberland 6–6000 for all the things that you don't have to come to town for yourself. What with thousands of people learning to vacation in town, we expect to burn up the wires. Many more than one-quarter of a million pieces of merchandise last year alone, were sold over A&S telephones. That means that during the year, we saved about 250,000 women half a million unnecessary trips by subway. A&S has by far the greatest tele-

phone business in Brooklyn, and so far as we know, is second in all the United States. Our tremendous switchboard has every position filled by operators so skilled, that they have been known to fill a $500 order for Delco Oil Heat as readily as they send a dozen golf balls over to your club. They wait on you via 'phone as efficiently and crisply as an over-the-counter sales-person. They've opened Convenient Payment Accounts entirely over the telephone. They are so expert in choosing merchandise, that many women who have never seen the face of their " favorite " telephone shopper, have come to call for a particular one who is more familiar with their whims than their own husbands. It's a stupendous thing—this faith of the community in A&S.

Personnel

The training of telephone sales-clerks is just as vital as the training of any other sales group in the store. They should be under the direction of a manager and supervisors as highly skilled as possible in the store's merchandise, its delivery system and its sales policies, as well as in the peculiar problems relating to telephone merchandising itself. The manager should be of sufficient calibre to sit in with the store's management and to direct the all-important coördination of his bureau with the advertising and other departments of the store.

Space limitations forbid a full outline here of what constitutes a training program for the personnel of a telephone shopping bureau, but this is a subject so familiar to telephone people that it can be supplied locally in almost any community of size in the country.

Advertising

Given a properly-equipped and adequately manned telephone order bureau, it remains a problem of major importance to make it fit snugly into the store's merchandising plan, and particularly into its advertising practices.

It goes without saying that a department store so alive to its telephone trade as to establish such a central bureau as we have described also develops its advertising so that the customer can visualize its current offerings as nearly as possible without actually seeing them. The advertising takes on something of the atmosphere of the highly-detailed mail-order catalog and less space is devoted to the alluring "bargain" designed purely to attract the customer to the store. The telephone number appears prominently with the store's signature and is repeated throughout the advertisement to emphasize the telephone specials, frequently with the direct invitation to order by telephone.

Coöperation between the advertising and telephone departments should be a matter of hourly association. The success of the department is dependent on the proper selection of those items in each day's advertising that should have adequate telephone emphasis. At the same time the telephone specials should be well illustrated and accurately described as to size, color and price, so that the purchaser may be able to visualize the merchandise clearly. No mistake is made by the advertising departments that use direct mail catalogs as their guide in this respect.

Care must also be exercised that the advertising is so developed that the volume of telephone orders will be sufficiently uniform not to overtax the ability of the equipment or personnel to handle it. At the same time it should be designed to supply a sufficient load factor to keep the telephone personnel busy as long as it is on duty. This is a matter requiring fine judgment and supervision and much can be done by the careful determination of the best items to feature to the telephone trade, careful planning to meet the extra load of advertised sales, et cetera. Such factors have much to do with the ultimate success and the degree of profit of the telephone department and afford at the same time the best possible check upon the effectiveness of the store's advertising. A few examples of department store telephone advertising are shown in Figure 6.

If we could put added emphasis on the importance of this point we would do so. Perhaps it is enough to state that about 75 per cent of the telephone orders received in well-equipped departments are for articles currently advertised

Fig. 6. Examples of How Big-city Department Stores Invite Telephone Orders by the Inclusion of Their Telephone Numbers in Newspaper Advertising.

in newspapers. One large store sold 549 dresses in one day by keeping its telephone board open between 6 P.M. and 9 P.M. and advertising this fact.

Public Attitude Toward Telephone Shopping

In any consideration of telephone merchandising, the buying public is a factor of no less importance than the department store itself. Studies in telephone circles have not neglected this field, but have attempted to establish whether the shoppers would be likely to respond to the invitation to shop by telephone even if it were to be more generally extended to them.

Do shoppers want to buy by telephone?

Considerable uncertainty has prevailed on this point. It is not unusual to hear women say " I don't telephone my orders because I'm never sure I'll get them on time"; or " They never send what you want unless you pick it out yourself"; or " I enjoy doing my own shopping and marketing, and have time enough to do it."

Several surveys have been made in an attempt to get a rough approximation of the extent to which this negative attitude toward telephone shopping should be considered as a factor in influencing department store policy. Two of these are enough to illustrate why we feel that, at the present stage, public attitude seems to be a factor influencing the stores in favor of greater rather than less attention to telephone orders.

The first of these studies was made in a city whose home telephone development is about 40 per cent, placing it in the lower group of cities in this respect. In a series of nearly 4,500 personal interviews with householders—principally women—the question was asked " Do you use the telephone for shopping or do you insist on seeing most of the things you buy? " Analysis of the replies indicated that some 40 per cent of the telephone subscribers showed a willingness to buy by telephone.

In another city, where the home telephone development is in the high ratio of about 60 per cent, 800 telephone subscribers were asked the question "Do you like to shop by telephone?" In this case the affirmative answers slightly out-numbered the negative, 404 of the householders answering "Yes" and 396 answering "No." That is, over half were favorable to telephone shopping.

In neither of these cities does the department store business handled by telephone equal as much as 10 per cent of the total. While the per cent of merchandise which can be bought satisfactorily by telephone is not known, we are forced to the conclusion that the inclination to shop by telephone, indicated by 40 to 50 per cent of the people interviewed, is much greater than the telephone shopping actually done with department stores. We may also reasonably infer that the inclination would be still higher if the department stores in these cities were to make more vigorous efforts to reach the telephone market and were more adequately organized to handle telephone orders with accuracy and dispatch.

The principal reasons for this favorable attitude on the part of the public seem from our observation and studies to be as follows:

It saves the time consumed in traveling the increasing distances between the downtown stores and the residential sections.

It saves the inconvenience of traffic and parking conditions in the congested shopping center.

It provides a shopping opportunity for employed persons who are not free during store hours.

It permits of shopping in all weathers.

It enables the selective shopper to make her final selection without returning to the store in person.

It provides a shopping medium for those confined to home by the care of small children, or by illness of self or family.

What do shoppers buy by telephone?

This is an interesting question and one on which a fairly adequate amount of evidence is on record. We may sum up the answer generally by saying that they prefer to order in this way articles that they have seen before, that are subject to frequent re-order, or that are either packaged or trade-marked so that they are generally familiar to the public without previous examination.

An exact record was made of the items included in the 491 orders previously referred to. That the number studied is not large merely serves to emphasize the fact that no one department monopolizes the benefits of telephone merchandising. The fact that the observation was made in early spring explains the high ranking of garden supplies. It may surprise some that shoes lead gloves, or that more hosiery is ordered by telephone than handkerchiefs and neckwear combined. However, this is not unusual and we are safe in accepting this list as fairly representative.

Toilet Articles	145
House Furnishings	136
Garden Supplies	124
Men's Furnishings	98
Lamps	89
Domestic Supplies	82
Hosiery	68
Upholstery	51
Shoes	49
Infants' Furnishings	48
Children's Furnishings	44
Uniforms	26
Ladies' Underwear	23
Boys' Furnishings	19
Library Supplies	19
Furniture	17
Women's Coats, dresses, etc.	15
Handkerchiefs	13
Stationery	11
Gloves	10
Neckwear	8
Toys	7
Luggage	6
Leather Goods	4
Sporting Goods	3
Corsets	2
Furs	1
Total	1118

The results of another study made in one of the larger stores are also enlightening as showing the distribution of telephone sales by departments, based on cash volume:

House Furnishings	34.62%	Bedding	7.76%
Rugs	12.30	Upholstery	5.24
Drugs	10.50	Table Linen	5.04
Groceries	8.82	Toilet Goods	4.83
Chinaware	8.17	Men's Furnishings	2.72

It seems rather clear from the studies that have been made up to the present time that the readiness of retail merchants to do business in the way the customer wants it done, as well as the obvious benefits to the stores in doing so, may well lead to a growing interest in telephone shopping on the part of our large department stores. It remains for the telephone companies to lend such aid as will work to the best advantage of the stores and of their customers.

JOHN M. SHAW

The author is indebted to the staff of the Commercial Engineer of the American Telephone and Telegraph Company for much of the data contained in this article and for assistance in its preparation.

Telephone Power Plants

ALEXANDER GRAHAM BELL'S original telephone depended upon magnetomotive force, generated by the vibration of an iron diaphragm in the field of a permanent magnet, for the conversion of sound waves into electrical waves. The power generated by this method was naturally weak and the distance over which conversations could be carried on was very limited. In the beginning the instruments used for transmitting and receiving were identical. It was soon recognized that if the telephone was to be a commercial success, its power output, under the direction of the human voice, must be increased. The development of the battery type transmitter followed.

With the introduction of the battery type transmitter, the vibrations of whose diaphragm controls, through carbon contacts, the current output to the telephone line, there was established in principle the transmitting medium which remains to the present day.

The average voice energy leaving the mouth of a speaker is of the order of 1/100,000th of a watt. The electrical output of the transmitter under the control of its diaphragm is several hundred times greater than the power of the voice which reaches the diaphragm. Therefore the transmitter, under the direction of the human voice, serves in the dual capacity of a converter of sound waves into electrical waves and an amplifier.

From the original battery transmitter two types of instruments have been developed: the local battery instrument, used where the power supply is individual to each telephone; and the common battery instrument, used where the power to all transmitters is supplied from one common source of energy at the telephone office.

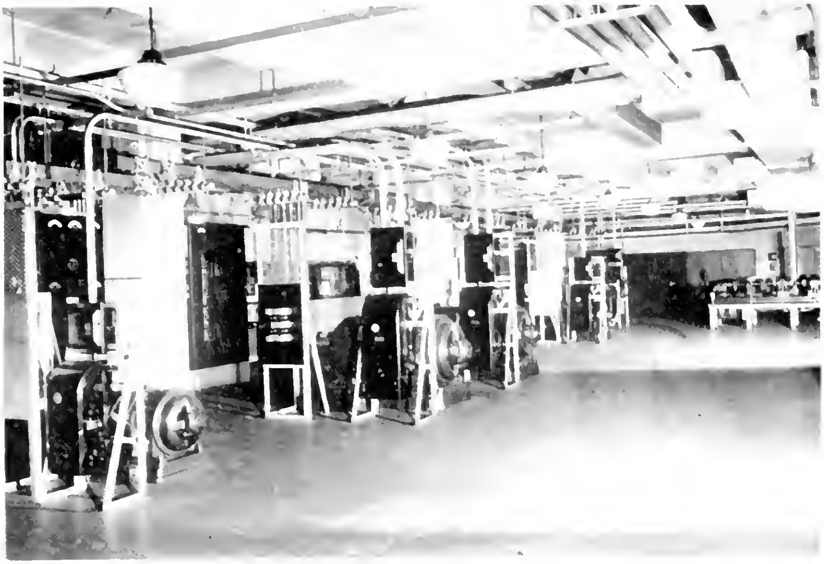
The first commercial telephones of the battery type, generally known as magneto telephones because of the hand operated magneto generators used in them for signaling purposes, used a local source of battery supply. This type of telephone has certain advantages, and for rural lines and small isolated exchanges it is still the most desirable instrumentality of telephony in many cases.

In the early days of the telephone the bluestone or crowfoot battery was the principal source of power. The Fuller or mercury cup type of battery was next used, then the Le Clanche cell, using carbon and zinc elements with a sal ammoniac solution, and finally the dry cell. The dry cell was rather uneconomical in its early stages of development, but with the types of dry cells available today, long service life and comparatively low cost per hour of telephone usage obtain.

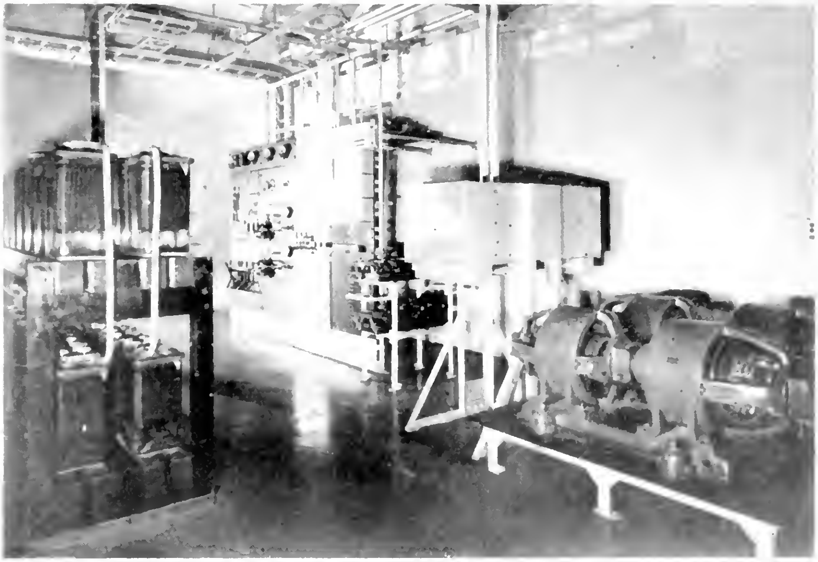
The growing demand for telephone service, the need for telephone switchboards of large capacity, and the uneconomical aspects of local battery supply under these conditions led to the introduction of the common battery or central energy type of telephone and central office equipment in the more densely populated areas.

The evolution of the common battery telephone has produced two types of service, manual and dial. Dial service is of two general types: the power driven panel, used in large multi-office areas; and the step-by-step, usually employed in medium sized and small exchanges and for dial private branch exchanges.

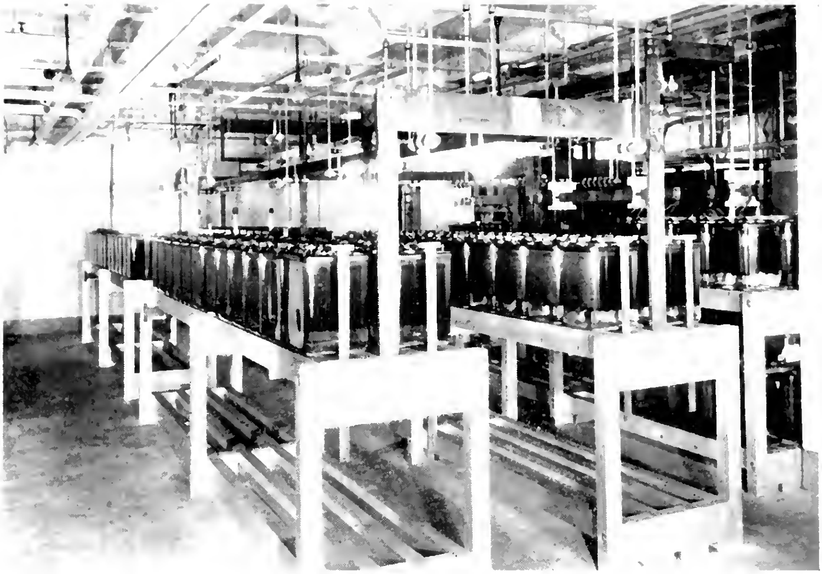
With the common battery instrument in general use commercially, the furnishing of power became a more and more difficult problem. It is apparent that the electric power requirements for the operation of two telephones over one pair of wires are not great. However, when it is considered that the number of telephones operated from a single office is very often in excess of 10,000, any part of which may be in use simultaneously, it will be realized that a real power supply problem is presented.



The Power Room of the Washington, D. C., District-Metropolitan-National Dial Offices, Showing Charging Machines in the Foreground and Ringing Machines in the Right Background.



The Power Room of the United States Capitol Private Branch Exchange, Showing Glass Jar Batteries and Charging Machines in the Foreground and Ringing Machines and Power Board in the Background.



Enclosed Glass Jar Storage Batteries in the Washington, D. C., Georgia Dial Office. The Space at the Bottom of the Racks Is Reserved for Future Battery Additions.

Wood Tank Batteries for the Washington, D. C., District-Metropolitan-National Dial Offices

Today, telephone power plants make use of 20 cycle, 135 cycle and 1000 cycle alternating current for signaling purposes; 4.5 volt, 16 volt, 24 volt, 38 volt and 48 volt direct current for talking and signaling; 110 volt positive and 110 volt negative direct current for prepayment coin box operation; and 24 volt, 48 volt and 130 volt direct current for telephone repeaters, teletypewriters and direct current telegraph. In addition, various tones are used to represent audibly certain existing telephone circuit conditions to the telephone users and to the operators.

Direct current for talking and signaling is generally furnished from storage batteries; alternating current, coin control current and tones by motor generators. In central offices where the volume of traffic is not sufficient to justify the generally used sources of supply, other sources more economical, such as dry cell operation of coin control apparatus, may be substituted.

Most of the voltages and frequencies required for telephone exchange operation are not furnished by any commercial source of supply. In view of this, and also to insure continuity of telephone service and freedom from extraneous noises, power plants for common battery offices generally employ storage batteries charged or floated by means of generators driven by motors which receive power from the commercial source. As referred to later, rectifiers are sometimes used in place of motor generators for converting the commercial power to a form suitable for use on telephone circuits.

Controlling factors in the design of a telephone power plant are: the amount of traffic (in messages) to be handled through a given office or group of offices, and the holding time, or length of time the connections are maintained between telephones. While the amount of current flowing through a telephone transmitter when connected for an average conversation is, say, 85/1000ths of an ampere, there are always at least two telephones connected and also additional current is always required to build up and hold the connections, to restore the equipment to normal after the conversation is finished, and to operate the supervisory and signaling equipment.

For the average manual office connection 35 ampere seconds are required to build up a connection and restore the equipment and 72 ampere seconds are required for each 100 seconds of conversation. For a dial office connection 38 ampere seconds are required, on the average, to build up a connection and restore the equipment and 43 ampere seconds are required for each 100 seconds of conversation.

From this small beginning, the power required for a single connection, the power requirements increase until we find demands reaching hundreds of amperes during the peak traffic hours of the day. The generation and distribution of this relatively large amount of energy, at low voltage, without noise interference in the telephone circuits, at a minimum of cost, requires some ingenuity.

In order to minimize generator noises in the telephone system, the early charging generators were of special design supplying power particularly free from fluctuations which would introduce noise in the telephone circuits. Some few years ago adequate filter equipment, consisting of a choke coil of high impedance and low direct current resistance, together with an electrolytic condenser of high capacity, was developed. The use of this filter equipment makes it possible to employ commercial generators, with consequent lower costs. Voltage control within narrow limits is conducive to reliable equipment operation, and automatic voltage regulators can be associated with the generators as the means of voltage control.

Telephone power plant motors, motor-generators and rectifiers are operated from commercial power sources wherever this is practicable. There are relatively few places at the present time where commercial power is not available. Telephone service must be a continuous service, and not subject to interruptions due to power failures, even though these may be of very short duration and infrequent occurrence. The telephone company is a highly interested party in the reliability of commercial power companies' service, since the continuity of this service has a direct bearing on the telephone reserve power requirements.

Motors which drive the panel dial office connecting mechanism are designed for operation from either commercial power sources or from the 48 volt storage battery of the telephone plant. Stopping of these motors results in complete failure of the telephone service within, and to and from, the office in which this stoppage occurs. Dual operation is provided so that in case of commercial power failure the motors will be automatically transferred by a switching mechanism to battery operation.

Assuming a fully charged battery at the time of commercial power failure, the reserve capacity in a given plant is generally sufficient to operate the office or offices served for several hours with normal current demand. This condition obtains where the power supply is reasonably reliable and precautions have been taken to have the power fed from two sub-stations over different feeder routes. If it is felt that there is a possibility of longer interruptions to commercial power service, the battery reserve may be increased or engine driven generators may be provided.

In the larger centers, such as large manual or dial offices, the commercial power company usually supplies the power at primary voltage into the transformer vault, where stepdown transformers are installed. From the transformer vault the low voltage power is taken to the usual house service panels for distribution to the telephone power plant. Motor generator sets then develop the required telephone plant operating power with the proper characteristics. Bus bars or leads from the generators are run to the battery control panel, where the connections are made to the storage batteries. From the battery control panel, large copper wires go to the various distributing fuse panels supplying power to the individual telephone circuits.

Fuses and switches at the battery control panel rank in current carrying capacity with those of commercial power plants, although the telephone voltages and total energy demands are much lower. As a precaution against delay in replacing blown fuses, most of the circuits leaving this panel have double-throw short-circuiting switches for by-passing a blown fuse and introducing another fuse into the circuit.

Telephone circuit design provides for arranging the power requirements of individual circuits so that one or more circuits can be supplied by a 1-1/3 ampere fuse or a 2 ampere fuse. The fuse panels and fuses are so designed that fuses of the proper capacity must be used in each circuit. Alarm circuits stand ready to call assistance in all cases of power interruption.

Economy in power costs, particularly in large telephone plants, is realized when practically all of the energy is supplied directly from the motor generators, without the losses incident to storage battery operation. Hence, the storage battery acts as a reservoir for emergencies by being permanently connected to the central office bus bars, and carries the load only during the hours when the current demand is too low to justify economically the operation of the generators.

The power requirements of an office having been determined, the design of the plant must provide for sufficient capacity and flexibility to care for the initial requirements economically. It must permit of ready expansion and provide for the ultimate office load. Bus bars, for example, are in most instances installed for the ultimate demand. Batteries are usually installed with tanks of sufficient size to care for the maximum number of plates required. The battery room for housing tank type batteries would, of course, be of maximum size for the office, from the beginning.

Recently the battery manufacturers have developed a sealed glass jar type of cell which obviates a separate battery room, and which permits the installation of batteries adjacent to equipment. One of the many advantages of these cells is that the capacity of a given plant can be increased by installing parallel groups when and as the current requirements of the office increase.

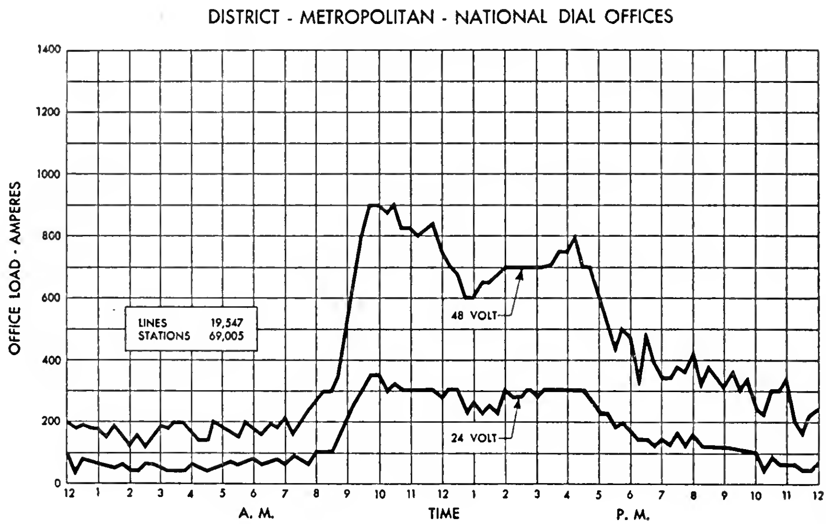
In manual offices the 24 volt source of supply carries a much heavier load than the 48 volt source, since the latter is used principally for transmitter supply on long distance connections, and for charging certain batteries at private branch exchanges which are fed from the central power plant. Conversely, in panel dial offices and in step-by-step offices the 48 volt source of supply carries the heavier load.

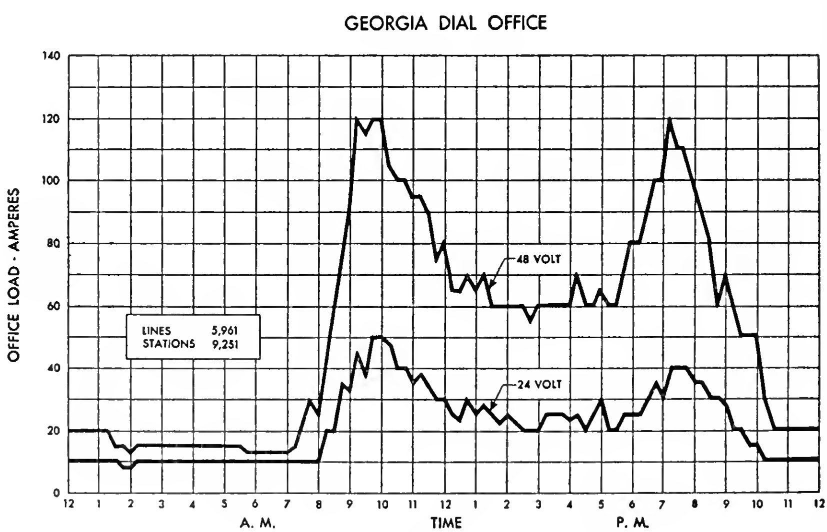
Office load records for December, 1933, in the District-Metropolitan-National and Georgia panel dial offices and North-Potomac-Decatur and Lincoln-Atlantic manual offices at Washington, D. C., are presented in graphic form, together with the number of lines in service at each office as of that period. These graphs indicate the characteristics of the traffic handled. District-Metropolitan-National offices, for example, have almost entirely business stations. While two peaks appear for the day, there is no evening peak such as is experienced in residential areas.

North-Potomac-Decatur offices serve an area that is almost evenly divided between business and residence traffic. The curves do not show the sharp falling off at the close of the business day indicated by the downtown offices, but on the contrary there is a steady volume of traffic between noon and six P.M., which then rises to a sharp evening peak, this being typical of residential service.

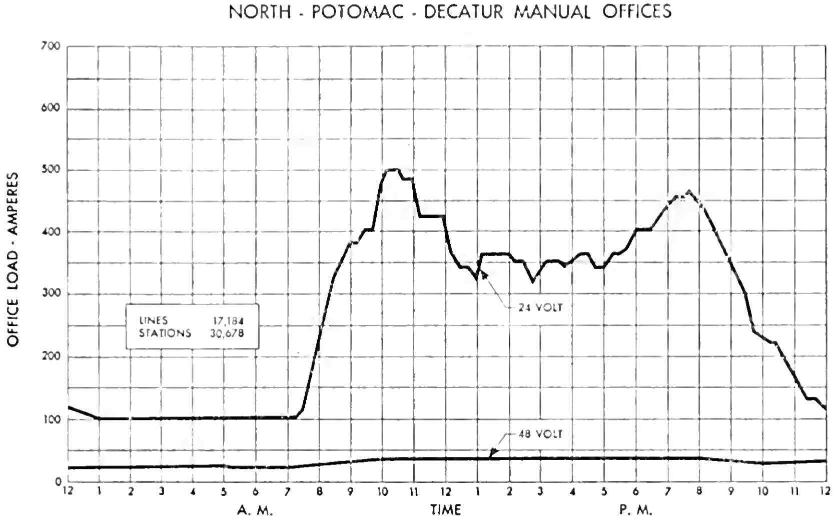
Lincoln-Atlantic offices are largely residential but with an appreciable business load. The drop in current consumption at the close of the business day is very marked, but the evening peak indicative of residential traffic occurs.

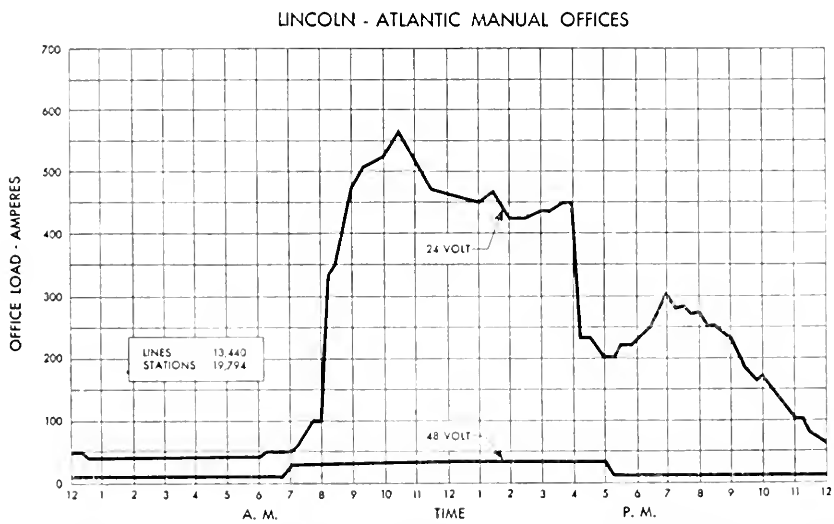
The Georgia office is almost entirely residential, with only the usual business service required in residential areas.





The Charts on This and the Opposite Page Indicate Typical Office Loads Over a Twenty-four Hour Period in Washington, D. C., Central Offices





THE CHARTS ON THESE TWO PAGES STRIKINGLY ILLUSTRATE THE PEAK OFFICE LOADS RESULTING FROM BUSINESS AND RESIDENTIAL USE OF THE SERVICE

Certain statistics for the city of Richmond, Va., are also presented in graphic form. There are two step-by-step dial centers here: Downtown, serving the principal business district, with a fair proportion of residence telephones; and Uptown, serving some business and a high percentage of residences.

The Downtown 48 volt demand has the usual high morning and close of business day peaks characteristic of central offices serving commercial districts, but there is not the sharp falling off at the close of the business day, due to the number of residential telephones. There is also the evening peak so familiar in residential areas.

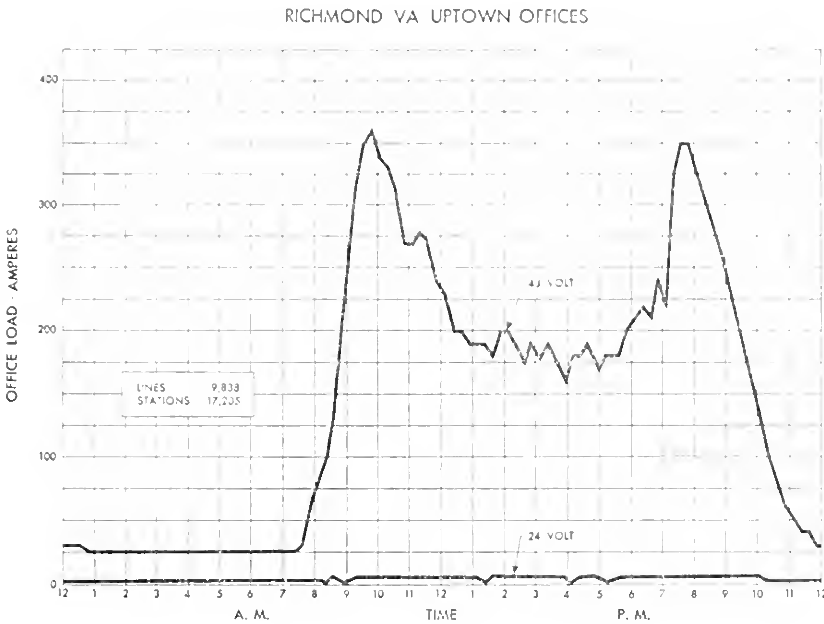
Richmond, being a heavy toll and repeater point, has an almost flat load of 275 amperes at 24 volts for the operation of this equipment.

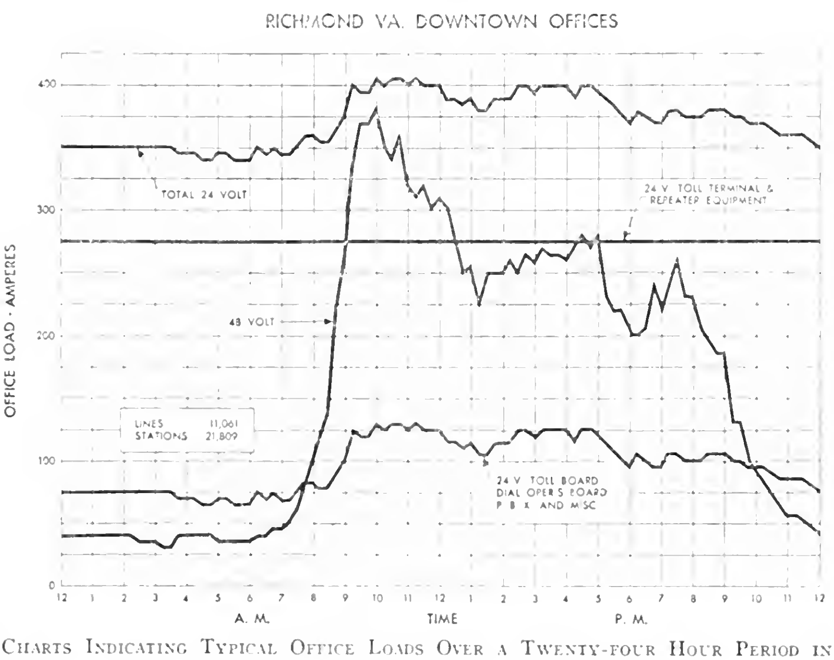
The toll board and the dial operators' board, which are also designed for 24 volt operation, are located in the Downtown building and supplied from the same power plant. Therefore the 24 volt load is very much heavier because of these power demands.

In the Uptown offices, the morning and evening power peaks, with a decided recession during the intervening hours, are indicative of residential areas. The small 24 volt demand is principally for supplying private branch exchanges.

Of course, at other times during the day current drains approaching the maximum or even greater than the maximum here recorded may be experienced for short periods. Events such as a snow or rain storm, a tornado, or the passing of the Graf Zeppelin over the city are responsible for such sudden and extreme activity.

Included in the central office battery requirements is the supply for those private branch exchange switchboards whose operating battery is furnished over wires from the central power plant. Where peak demands make the direct wire feed method of supply uneconomical, floater storage batteries, charged over





Charts Indicating Typical Office Loads Over a Twenty-four Hour Period in Richmond, Va., Central Offices.

wires from the central power plant, are used at the private branch exchange.

The use of the wire method of supply from the central plant is limited, either because of the distance between the central plant and the private branch exchange or because of the amount of power required by the particular private branch exchange. The number of private branch exchanges whose batteries cannot be directly supplied over wires from the central plant is increasing rapidly.

Whether rectifiers or motor generators are used for power supply purposes at the central office or the private branch exchange depends upon the type of power supplied by the commercial power company at the particular location, as well as upon the current requirements.

A power problem closely associated with that of supplying talking and signaling power is that of calling the subscriber's telephone. While there are many ways by which bells can be made to ring, 20 cycle alternating current is most commonly used. On single party lines, both sides of the circuit are utilized for operating the bell, while on party lines the subscribers' bells ring from either side of the line to ground. These operations require alternating current only, but experience has shown that what is known as AC–DC (alternating current-direct current) ringing current is the most satisfactory where intermittent or machine ringing is employed.

AC–DC ringing current is procured by placing a small, nine cell storage battery in series with the 20 cycle 100 volt alternating current derived from the ringing machine. The presence of the direct current component gives more positive action to the relay which stops the familiar intermittent ringing when the receiver is lifted from the hook.

To keep the calling subscriber advised as to the progress of his calls, a method of informing him when ringing current was being applied to the called line was desirable. This led to the development of a means for diverting a small part of the ringing current through a by-pass to the calling subscriber.

Signaling between offices in a local exchange area is usually accomplished by means of direct current. When signals are to be sent to more distant offices, as in the case of toll connections between cities, the 20 cycle ringing current is used. When circuits were designed for simultaneous telephone and telegraph operation, it was found that this low frequency was not suitable, and 135 cycle current was used. Later 1,000 cycle current was introduced. Motor generators supply the 135 cycle and 1,000 cycle current. Where the load is light, vibrating relays generate the 135 cycle current and vacuum tube oscillators generate the 1,000 cycle current.

Tones of various sorts have been used for nearly a third of a century in the Bell System, for passing certain types of information over telephone circuits. With the increasing use of the dial system, some of the more generally used tones have become very familiar to the subscriber. The tones obtained from supplementary equipment associated with the ringing machines may be divided into three fundamental groups: a high tone of about 480 interruptions per second, a low tone of about 160 interruptions, and an audible ringing tone. The low tone is further modified by interrupting 60 or 120 times a minute to give the familiar busy signal.

Extension of the distances over which commercial telephone service could be given brought its own power supply problems. The level to which power can be raised in the individual telephone circuit is limited, since high power levels will introduce cross-talk in adjacent circuits in the central offices, in cables, and on open wire lines.

Successful long distance service over great distances was made possible by repeaters which came into common use with transcontinental telephony. The perfection of the vacuum tube for telephone purposes greatly facilitated the simplification of the repeater, and materially extended the use of fine wire in toll circuits.

The increasing use of fine wire all-cable toll circuits has resulted in a marked increase in the use of telephone repeaters and the establishment of repeater stations for the sole purpose of housing this type of equipment. Repeater filaments are usually operated from a 24 volt power supply and plate current at 130 volts. Power plants for repeater stations with filament supply capacity of 800 amperes have been installed. The same precautions for continuity of service are taken for these stations as are taken for exchange service.

Direct current telegraph and teletypewriter circuits at the central office require the same power sources. They make use of 48 volt and 130 volt power supply.

Circuits equipped to handle several telephone messages simultaneously, technically known as carrier circuits, make use of vacuum tubes and other equipment generally similar to telephone repeaters. While carrier equipment is in general use, the power demand is relatively small and has not created any outstanding needs for specially designed power plants.

Development and research have materially increased the range of the present-day telephone over its forbears and have reduced the energy requirements of the individual transmitter. However, the upward trend in telephone traffic, together with the exacting demands of modern telephone usage, have resulted in greater total power consumption. From the original telephone of Dr. Bell, with the ability to generate its own electricity for transmitting sound, there has developed the world-wide telephone service of the present day with the need for power plants larger and more intricate by far than one would appreciate from consideration of the minute energy requirements of the simple connection from one telephone to another.

G. L. Weller

The International Telephone Conferences of 1934

THE International Advisory Committee on Telephony (generally known as the C. C. I. F. to distinguish it from the similar committees for telegraphy and radio) was formed ten years ago by the joint action of leading telephone administrations in Europe, originally for the purpose of improving international telephony in the European region. This Committee completed its tenth year of work by meetings of four of the technical commissions in Stockholm on June 4 to 15, followed by a Plenary Assembly of the entire Committee in Budapest in the week September 3 to 10. These meetings crystallized the work done during the past three years by the technical commissions dealing with plant questions and during the past two years by the commissions dealing with questions of traffic, rates, and operation. They also laid out the program of work for the coming two years to be reviewed at the next Plenary Assembly, at Copenhagen in 1936.

The fact that the work of the C. C. I. F. has been highly effective is indicated by the very great improvements which have been made in international telephony in Europe during the past ten years. Ten years ago, an attempt to set up experimentally a telephone circuit between London and Rome, a distance of 900 miles, was unsuccessful even though it was preceded by months of arrangements between the engineers of the countries involved. Today, a network of efficient telephone circuits connects together the important cities of Europe. According to a survey made by the International Chamber of Commerce, in 1924 there were only 75 international telephone services in Europe, counting as one service each pair of countries between which connections could be made. Today the number reported is 414.

During this decade also the opening of commercial transatlantic telephone service in 1927 has been followed by a rapid extension of intercontinental telephone connections and has brought the total number of international telephone services, as listed by the International Chamber of Commerce, up to 1324. Anticipation of this fact was largely instrumental in leading the C. C. I. F. to expand its activities from a European to a world-wide scope and to invite the American Telephone and Telegraph Company and other telephone administrations outside of Europe to become members of the Committee. Since 1929, when the American Company joined the C. C. I. F., the Bell System has been represented at all important conferences, including both series of meetings this year.

A part of the work of the C. C. I. F. is devoted to questions for which world-wide agreement is desirable. This work is directed principally toward questions of such a nature that their coördination in the telephone systems of the different continents will facilitate the future growth of intercontinental telephone service. This includes agreement upon standards for the plant forming the continental portion of an intercontinental connection and coördination of operating practices and types and conditions of service offered. In some particulars, such coördination has already been established by the work of the Committee. In many cases, it is necessary first to reach agreement on common objectives and on common methods of measuring and expressing the technical quantities by which performance is measured.

An illustration of this which was important in the considerations of the Committee this year is given by the question of transmission standards to be applied to plant. While a few years ago the European administrations, under the stimulus of the C. C. I. F., generally adopted a standard method of using measurements of the energy efficiency of a telephone circuit as a means of expressing its transmission performance, recently the Bell System abandoned this method in favor of measuring transmission performance in terms of service results, the so-called " effective transmission " method. The C. C. I. F. has now accepted in principle the fact that transmission performance should be rated on this basis rather than directly from the results of any technical measurements. Active work is now under way toward world-wide agreement on means for putting this criterion into practical effect, both in rating the over-all transmission performance of circuits and in determining and expressing the effect of all the various constituent elements. This involves, as one step in the process, agreement upon methods of measuring quantitatively such items as noise, propagation time, band of frequencies effectively transmitted, sidetone, echo, crosstalk, and distortions of various types, and on means of expressing the effect on over-all performance of variations in the transmission characteristics of any or all of the numerous parts of a long international telephone circuit. Material further progress was made in this whole problem as well as in other matters of interest in connection with intercontinental telephone services in the work of the Committee this year.

A considerable part of the work of the Committee continues to relate to the coördination of the European toll network. This includes numerous problems of plant construction, of commercial and operating practices, and of rates. An interesting illustration of problems of this type on which progress was made this year is the work done looking toward the establishment in Europe of a general toll switching plan of the same general nature as that adopted by the Bell System in 1929. In this work, many difficulties arise because of the fact that the governmental departments and operating companies who give telephone service in the thirty-three different European countries necessarily work, to a large extent, independently of each other. As a result, it has not been possible as yet to determine one important phase of a general toll switching plan, namely the location of regional centers and the other important switching centers. Considerable progress was made, however, in certain features of the toll switching plan, including important work looking toward specifying the transmission characteristics of the different circuit elements which may go into any long switched international connection in Europe in such a way as to insure satisfactory transmission over the completed connection.

An important trend of the work relating to the European region is the liberalization of the procedures applying to various classes of service, particularly to the person-to-person service. Further progress in this direction was made at these meetings, bringing the conditions applied to the European services somewhat closer than before to the corresponding American services.

A feature of the work of the C. C. I. F. this year is the complete rewriting of the recommendations of the technical commissions, constituting the accumulated work of the past ten years, in so far as they are still in effect. The combined recommendations of the entire Committee, which will probably fill about 1,000 printed pages, will in their new form be grouped in a logical order and published in five volumes. The final editing of this revised text will be placed in the hands of a committee consisting of representatives of France, Germany, Great Britain, Cuba, and the United States.

Practically two weeks were devoted by the working commissions dealing with plant questions to their study of these questions in Stockholm and one week was devoted to the work of the Committee as a whole in the Plenary meeting at Budapest. An efficient method of procedure has been worked out. The specific questions to be studied have been assigned to the various working commissions by the previous Plenary Assembly. Between meetings, the consideration of these questions is conducted largely by correspondence. Occasionally, there are smaller meetings in the interim, such as a meeting held in

Paris in October of last year, attended by representatives of thirteen countries, for the consideration of technical questions and of programs of tests to be carried out by the administrations and by the laboratory staff of the C. C. I. F.

When the working commissions meet, generally about three months before the Plenary meeting, the assigned questions are discussed one by one, using as a basis the past correspondence. Often, as a result of this correspondence, the chairman of the technical commission has in advance of the meeting prepared concrete proposals to serve as a basis for discussion. There are no prepared papers presented at these meetings and all discussion is directed specifically to the questions under consideration. Following the discussion, a specific recommendation with reference to each of the questions is formulated. These proposals are circulated to all the administrations who are members of the C. C. I. F. and are voted upon by the following Plenary Assembly.

The questions to be assigned for further study are carefully considered. At Stockholm one entire day was devoted to the consideration of suggestions for future work received from various sources and definite recommendations were formulated, for consideration at the Plenary meeting, regarding the work to be assigned for the coming two years.

One who attends these meetings cannot but feel that, in addition to the specific accomplishments of the C. C. I. F., in the form of recommendations for the coördination of telephone service which are accepted by the interested administrations, there is much value in this periodic personal getting together of representatives of the telephone administrations of the world. The interchange of ideas which takes place in the informal discussions outside the conference rooms and the visits to telephone offices and factories of the foreign countries have a real value. It was interesting this year to note that, in spite of the many reports received in America of unsettled political conditions in Europe, this situation did not affect the cordial coöperation of the representatives of various European countries or prevent them from going ahead with the usual plans for a continuation in the future of their joint work for the further improvement of international telephone service.

H. E. Shreeve,
H. S. Osborne

Significant Changes in the Occupational Distribution of the American Population

DURING the past quarter of a century much progress has been made in solving many of the important economic and social problems affecting the industrial life of the American people, such as child labor, long working hours, sweatshop conditions for women, and unsatisfactory living standards. This progress has resulted largely from technical advances, increased labor efficiency, and improved management, while the status of the workers has been bettered by many social reforms and improvements in working conditions which have contributed to higher standards of living. These improved living standards have in turn created a better market for American goods, for new products, and for additional services, and the satisfaction of these wants has originated a new labor demand, thus tending to absorb the surplus workers displaced by technological developments. The present depression may have served temporarily to retard this progress in some directions, but it does not alter the fact that the gains up to 1930 were substantial and significant.

The far-reaching economic and social changes wrought in the United States during the 1910 to 1930 period[1] are reflected in the occupational statistics recently published by the Bureau of the Census. The figures on workers in various occupations tell the story of the expansion of many long-

[1] In the Thirteenth (1910) Census report on "Occupation Statistics," the Bureau of the Census, for the first time, published detailed statistics showing, for each of the more important industries and for each service group, every occupation that was numerically important, with the workers in the occupation classified by sex, color, nativity, and age. In 1930 the Census Bureau made its second attempt to classify the gainful workers both by industry and by occupation. In general, therefore, comparison of 1930 occupation statistics with those of 1910 should be more enlightening than comparisons between other census dates.

established industries and of the amazing growth of several new lines of activity, simultaneously with the waning of some old professions and trades.

Moreover, changes in the distribution of gainfully occupied workers among the basic industry and service groups and developments tending to improve the economic and social status of the working population have special interest to the telephone industry in so far as they affect the market for its facilities and services. It may, therefore, be worth while to consider briefly the important changes that took place in the number and distribution of workers by occupations during the past two decades and then try to evaluate their significance.

Gainful Workers[2] by Industry and Occupation

While the total population in the United States increased by one-third between 1910 and 1930, the change in the number of gainful workers in various industries differed markedly from this figure, several occupational activities gaining relatively much faster than did population and some even declining numerically. Such disproportionate changes can be accounted for by several factors.

In the first place, improved living standards since 1910 contributed to a considerable increase in the service industries (catering largely to domestic and personal needs, but including also governmental activities and professional pursuits in the fields of education, health, law, engineering, and entertainment). The gainful workers in these occupations increased by nearly 3,200,000, or 53.5 per cent, during the twenty-year period. In a general way, this reflects the social progress of the American people as well as the greater complexity of life under city conditions; nearly 27,000,000 more people lived in urban territory in 1930 than in 1910.

[2] The Census enumerators were instructed to include as "gainful workers" all persons who usually follow a gainful occupation, although they may not have been actually employed when the census was taken.

In the second place, and closely related to the foregoing situation, certain household functions have been transferred from the home to the shop and factory where they can be performed more efficiently and economically. For despite the greatly increased use of gas and electricity for cooking and household tasks, which lessens somewhat the labor previously involved in the use of coal, wood or oil, the kitchen seems to be used less than it was 20 to 25 years ago. This trend is indicated by an increase of 474,000 workers (109 per cent) in the food industry from 1910 to 1930—including bakeries, butter and cheese plants, and fruit and vegetable canning factories—and by an increase of 172 per cent in the number of restaurant, cafe, and lunchroom keepers during this period. A somewhat similar situation prevails in the slaughter of livestock for food. Whereas much of the slaughtering was formerly done on the farm or ranch where the meat animals were raised, the increase of 76,500 (87 per cent) in the number of workers in slaughter and packing houses since 1910 indicates that this operation has been largely transferred to industrial plants which are better equipped to handle the work.

Accompanying the increased absorption by commercial interests of certain domestic duties have been marked declines in the number of workers dependent upon employment in the home. For example, there were 172,700 (33 per cent) fewer independent launderers and laundresses in 1930 than in 1910, against an increase of 128,400 (114 per cent) in the number of laundry operatives; also in the same period there was a decline of 291,000 (65 per cent) in the number of dressmakers and seamstresses (not in factories). Thus, it is apparent that several basic occupations characteristic of the home have been taken over in increasing volume by organized industry during the past two census decades.

Finally, the rapid expansion of industries just getting under way in 1910, such as the automobile and electrical industries, and the rise of new industries, such as radio, aviation, and rayon manufacture, have provided employment for a vast number of workers. These developments have been particularly fortunate in view of the displacement of industrial labor by technological improvements.

The rise of some industries was facilitated and accompanied by a decline in the importance of some related activity. For example, the rapid development of the automobile was coincident with the decadence of horse-drawn transportation. While the gainful workers in automobile manufacturing plants increased by 535,000 (506 per cent) from 1910 to 1930, the number employed in wagon and carriage factories declined from 83,400 to 9,200 and the workers in harness and saddle factories dropped from 33,100 to 9,100. Between 1910 and 1930, dealers in automobiles and accessories increased from 4,600 to 61,500; garage owners, managers and officials increased from 5,300 to 70,000; and chauffeurs, truck and tractor drivers increased from 45,800 to 972,400. The number of workers employed in automobile agencies, and stores, filling stations, garages, greasing stations and automobile laundries—too few in number to be mentioned in the 1910 census—totalled 791,000 in 1930. During the same period, draymen, teamsters, and carriage drivers declined by 333,000 (75 per cent), blacksmiths by 108,000 (47 per cent), and hostlers and stable hands by 56,700 (90 per cent).

Certain occupational pursuits which showed only slight losses in workers, or even small gains, over the past two decades experienced sizeable declines in the number of gainfully occupied workers from 1920 to 1930. For instance, in agriculture, the abandonment of some marginal farms and the consolidation of other farms accounted for a reduction of 375,350 (6 per cent) in the number of farmers between 1920 and 1930. More widespread adoption of machine equipment in coal mining largely explains why there were 112,300 fewer coal operatives in 1930 than in 1920, while at the same time the increased use of automatic machinery in manufacturing released 161,600 machinists. Of course, there has been a great increase in the efficiency of men, machines, and methods during the past two decades, so that the output per worker has grown tremendously. This reflects the progress realized in industrial production since 1910, due largely to technological advances.

The decline in the importance of agriculture is further indicated by the fact that of the nearly 6,300,000 farm operators in 1930, about 1,900,000 reported 190,000,000 days of work for pay in 1929 at jobs not connected with the farms they operated. This was an average of 100 days per farm. Of those who worked off their farms, 14 per cent (or 267,000) reported 250 days or over, the average number of days being 302. It is clear from these figures that the farming operations of a very large number of these operators were incidental and supplemental to a wide range of other occupations.

The supervisory personnel in the manufacturing and mechanical industries—including managers and officials, foremen and overseers—increased from 300,000 in 1910 to 650,000 in 1930, nearly four times the proportional gain in all other workers in this group. This may reflect the increased complexity of modern manufacturing methods requiring greater emphasis on management and supervision of production than formerly.

Some of the principal divisions of industry which experienced notable gains in workers between 1910 and 1930 are shown in Table 1.

Number and Sex

Half the people in the United States 10 years old and over in 1930 were persons usually working at gainful occupations. And of the total population recorded at the last census, approximately 2 out of 5 were classified as gainful workers. Although there were about 11,000,000 more workers in 1930 than in 1910, the proportion gainfully occupied, both in the total population and in the population 10 years old and over, decreased materially over the 20-year period. While this de-

TABLE 1. INCREASE IN GAINFULLY OCCUPIED WORKERS, 1910 TO 1930, FOR INDUSTRY OR SERVICE GROUPS HAVING SIZEABLE GAINS

Industry and Occupation	Increase in Workers	
	Number	Per Cent
Extraction of Minerals—		
Oil wells and gas wells	143,141	260
Manufacturing—		
Automobile Factories	534,716	506
Blast Furnaces and Steel Rolling Mills	219,855	55
Car and Railroad Shops	96,078	74
Electric Light and Power Plants	220,197	320
Electrical Supply Factories	294,655	322
Food and allied industries	473,694	109
Furniture factories	107,827	67
Gas Works	61,680	116
Knitting Mills	66,898	62
Paper and Pulp Mills	88,993	98
Petroleum Refineries	144,081	485
Printing and Publishing	188,932	53
Rubber Factories	108,291	187
Silk Mills	74,868	78
Transportation and Communication—		
Construction and maintenance of roads, streets, sewers and bridges	217,195	92
Postal Service	114,116	67
Telephone and Telegraph Companies	309,695	115
Trade—		
Banking and Brokerage	414,071	197
Insurance	354,335	232
Real Estate	136,172	90
Wholesale and Retail	2,273,744	64
Public Service	516,823	97
Professional Service—		
Teachers	463,378	77
Technical Engineers	137,494	155
Trained Nurses	211,862	257
Domestic and Personal Service—		
Barbers, Hairdressers, and Manicurists	179,015	92
Cleaning, dyeing & pressing	73,258	493
Janitors and sextons	196,544	174
Laundry Operatives	128,440	114
Restaurant, cafe, and lunchroom keepers	104,574	172
Waiters and waitresses	204,995	109
Cooks	114,952	26
Other Servants	311,956	28
Clerical Occupations—		
Bookkeepers, cashiers and accountants	443,948	91
Clerks (except in stores)	1,276,502	177
Stenographers and typists	494,497	156

crease was general, it was, in fact, greater for males than for females, greater for children than for adults, greater in the South than in other sections of the country, and greater in agriculture than in other occupational fields.

The total number of males 10 years old and over who were reported as gainfully occupied in 1930 was 38,077,804, or 76.2 per cent, compared with 81.3 per cent in 1910. This decline was due only in very small part to a change in the age composition of the working population. Rather, it can be very largely accounted for by the increased school attendance and by more general and earlier retirement from active work.

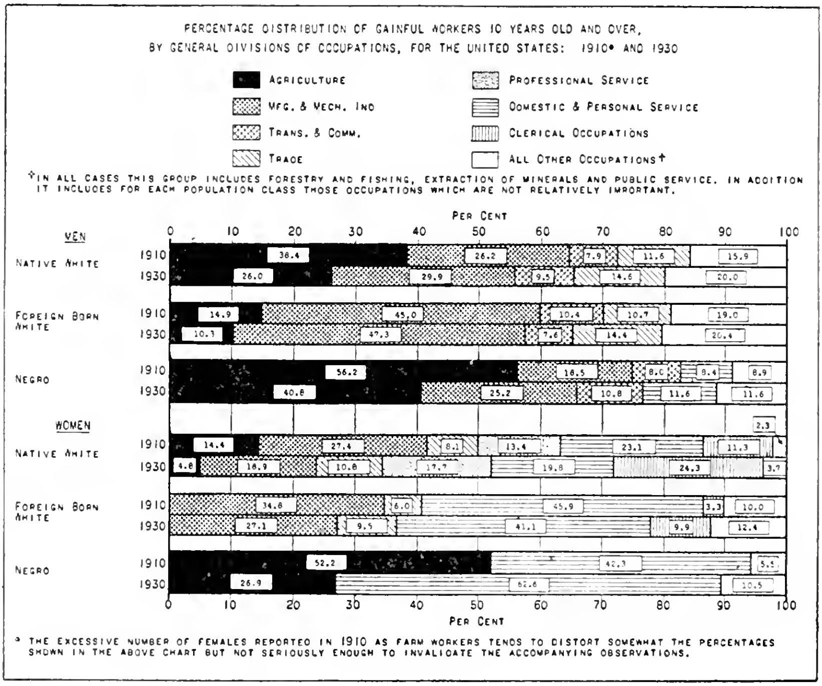
A direct comparison of female workers in 1930 with the corresponding number in 1910 is not practicable because of certain peculiarities in the census count in the latter year.[3] However, the proportion of females 10 years old and over gainfully occupied in 1930 was 22.0 per cent as compared with 21.1 per cent in 1920, which continues the trend that has been in evidence since 1870, with the exception of 1910 already explained. This emphasizes the increased importance of women in industry during the past decade, a development that will receive further attention in a later section.

Color and Nativity

Although the native-white class has the smallest proportion of persons 10 years old and over gainfully occupied—the percentage declining from 49 in 1910 to 47 in 1930—this population class has formed an increasing proportion of the total number of workers, rising from 65.4 per cent to 72 per cent during the 20-year period. This was due largely to the reduction of 400,000 foreign-born white workers between 1910 and 1930, but reflects also the fact that during this time the native

[3] There is considerable evidence that too many women were reported as farm laborers in 1910, the figure of 1,522,000 representing an apparent increase of 860,000, or 130 per cent, over 1900. The excess number reported was confined largely to farm laborers working on the home farm, and was due to a difference in the instructions to enumerators at the two censuses.

white population of working ages increased much more rapidly than the corresponding negro population. Negro workers increased by 310,000 from 1910 to 1930—although they were outnumbered in 1930 by the foreign-born whites by nearly 2,000,000—while the other races gained 540,000 workers. (This figure is partly fictitious, due to the fact that Mexicans were counted as a separate class for the first time in 1930.)



Incidentally, the negro race has the highest proportion of any population class of those aged 10 years and over gainfully occupied, although this percentage declined from 71 in 1910 to 59 in 1930.

The figures in the accompanying chart show the reduced importance of agriculture in 1930 for both sexes of all nativity groups as compared with 1910, although it is still a major activity for negroes and native white males. Manufacturing and mechanical pursuits have attracted an increased proportion of all male workers—notably negroes—while employing relatively fewer white women. There have been rather heavy gains in the proportion of white workers engaged in trade. Proportionally large numbers of white women were drawn into professional service, mostly as school teachers and trained nurses, while at the same time this nativity class declined in relative importance in the field of domestic and personal service. Negro women apparently transferred their activities in large numbers from agricultural labors to domestic and personal service, until in 1930 five of every eight colored women were classed as servants. But perhaps the most pronounced increase between 1910 and 1930 was that of white women working at clerical occupations, associated principally with trade and professional pursuits.

Age of Gainful Workers

The increased concentration of workers in the broad age group 20 to 64—the proportion rising from 83.7 per cent in 1920 to 85.8 per cent in 1930—resulted from the marked decline in child labor (10 to 15 years) and in young workers (16 to 19 years). Although the figures for earlier censuses are not exactly comparable with those for 1920 and 1930, such statistics as are available for 1910 and 1900 indicate that this concentration of workers in the middle age groups has been the result of a continuous trend in this direction for several decades. This concentration has been more pronounced among women than among men.

As might be expected, the proportions both of males and females gainfully occupied in all age groups between 20 and 64 were higher in 1930 than in 1920, except among males 20 to 24 years old, in which group there was a moderate decrease. There was also a slight decline in the proportion of males 65 years old and over gainfully occupied. Furthermore, for each sex, there was a striking and general decrease from 1920 to

Table 2. Age of Gainfully Occupied Workers; 1930 and 1920 *

Age Group	Percentage Distribution of Gainfully Occupied						Proportion of Persons Gainfully Occupied					
	Total		Male		Female		Total		Male		Female	
	1930	1920	1930	1920	1930	1920	1930	1920	1930	1920	1930	1920
10 years and Over........	100.0	100.0	100.0	100.0	100.0	100.0	49.5	50.3	76.2	78.2	22.0	21.1
10 to 15.......	1.4	2.5	1.2	2.2	1.9	4.1	4.7	8.5	6.4	11.3	2.9	5.6
16 to 19.......	8.2	9.5	6.7	7.7	13.6	16.5	43.4	52.3	55.8	68.0	31.3	37.0
20 to 24.......	14.6	14.2	12.6	12.5	21.8	21.1	65.7	63.9	89.9	91.0	42.4	38.1
25 to 44.......	45.7	45.7	46.7	47.1	42.3	40.0	61.7	60.7	97.5	97.2	25.4	22.4
45 to 64.......	25.5	23.8	27.6	25.9	17.8	15.8	58.0	58.2	94.1	93.8	18.7	17.1
65 and Over....	4.5	4.1	5.1	4.5	2.5	2.3	33.2	34.3	58.3	60.1	8.0	8.0
Unknown......	0.1	0.2	0.1	0.2	0.1	0.2	47.3	48.9	59.9	61.5	31.8	28.0

* Corresponding figures for 1910 are not available on a comparable basis.

1930 in the proportion of children and young persons 10 to 19 years old who were gainfully occupied. This decline is significant and deserves further attention.

Children in Gainful Occupations

Notwithstanding an increase of nearly 3,500,000 in the number of children 10 to 15 years old in the United States between 1910 and 1930, the number of such children gainfully occupied decreased from 1,990,000, or 18.4 per cent, in 1910 to 667,000, or 4.7 per cent, in 1930. This decline resulted in part from improved standards of living and in part from increased legal restrictions upon child labor, better compulsory school attendance laws, and more efficient enforcement of these two classes of laws.

Over 70 per cent of all gainfully occupied children in 1930 were reported as engaged in agriculture, with seven out of every eight of those so engaged being classified as unpaid family workers. This means that only two-fifths of the total number counted as occupied were actually working for wages. The great bulk of those not in agriculture were divided between the manufacturing and mechanical industries, trade, and domestic and personal service. Geographically, the degree of child labor appears to have varied inversely with the general standard of living and the extent of small farming, as the proportion of children gainfully occupied is highest in the southern states and lowest in the northeastern and far western regions.

The distribution of gainfully occupied children by population classes is in the ratio of approximately two native whites for each negro, but the proportion of total native-white children reported as working in 1930 was only 3.3 per cent as compared with 16.1 per cent for negroes. These percentages were much higher in 1910, when the corresponding figures were 14.3 and 46.6, respectively. This comparison emphasizes the marked reduction in child labor which has taken place during the past two census decades.

Extent of Gainful Employment Among Old People

In analyzing the changes in the number and proportion of old persons gainfully employed, a direct comparison between 1930 and 1920 is possible only for the age group 65 years and over. However, this is quite satisfactory because, in general, age 65 represents the dividing line beyond which the operation of industrial pension systems becomes effective and it also marks the point at which old age dependency begins to be a real problem. In view of the fact that those aged 65 and over formed 5.5 per cent of the total population in 1930 as compared with 4.7 per cent in 1920, and that the proportion of persons in this age group who were gainfully occupied declined slightly during this period, it is evident that the importance of old age as in itself a potential cause of dependency is becoming more serious.

In spite of the fact that a person 65 years old or over finds it difficult to secure or retain profitable employment, a considerable proportion of the people in this age group are still gainfully occupied, amounting to one-third of the total number. As might be expected, the extent of gainful employment varies widely between the sexes, slightly less than one-twelfth of the women and nearly three-fifths of the men coming within the group. While some of the 1,400,000 males 65 years old and over who were not employed in 1930 were undoubtedly independent, nevertheless this number represents some measure of the extent of old age dependency.

With few exceptions, the southern and far western states have from three-fifths to two-thirds or more of their aged males gainfully employed, while in the northeastern and north central regions the corresponding proportions are well below the national average. This alignment follows the usual experience that agricultural and rural conditions afford more opportunities for elderly workers to continue in gainful employment than urban and industrial environments. The size of the negro population also appears to affect the situation, as there are indications that the colored people tend to continue in gainful employment to a later age than the non-colored races.

The states leading in the employment of elderly women show a somewhat similar alignment to the proportion of old men gainfully occupied. In the distinctly southern states, this situation is probably due to the fact that the majority of employed women are colored, and that they are engaged mainly in domestic service or in agriculture, in both of which there are more chances for an elderly worker to be useful than there are in industrial pursuits.

Women in Industry

The number of female workers in industry more than doubled between 1900 and 1930, with the decade 1920–1930 showing an increase of 2,200,000 employed women. One important factor in the movement of women into industry has been the shift of several occupations such as baking, canning and preserving, laundering, and sewing from the home to the factory; all this has reduced the economic importance of woman in the home. The tendency has been for her to seek outside employment, with the consequence that a wholesale shift from the kitchen to the office, store, and mill has taken place, thus emphasizing the increased economic independence of women during recent decades.

While most occupational groups recorded substantial gains in female workers between 1920 and 1930, there were two broad industrial fields in which the number declined; agriculture by 173,000 and manufacturing by 44,000. However, these losses were wholly or largely due to the reduction in child labor, as the number of girls 10 to 15 years of age reported as gainfully occupied in agriculture decreased by 62,000 and in manufacturing by 48,000 during this decade.

The other principal industrial groups employed very sizeable additions in the number of women during the past census decade; 290,000 in trade, 509,000 in professional service (the teaching profession is the stronghold of women), and 565,000 in clerical occupations. But the most abundant new opportunities for woman's energy during the 1920's occurred in the personal service division—in the fields of beautifying, waiting on table, and domestic service—where employment was provided for nearly 1,000,000 additional workers. These may be regarded largely as luxury or prosperity trades. In fact, most of the service and clerical occupations in which women predominate are either prosperity or office routine jobs.

The entry of married women into outside occupations has been rapid in the decade 1920 to 1930. During this period the number of married women gainfully employed increased by 1,150,000, or 60 per cent, while the total number of married women increased by only 23 per cent. As a consequence, the married workers formed 29 per cent of the total gainfully occupied women in 1930 as compared with 23 per cent in 1920.

Another phase of the employment of women in industry is presented in the census data as to whether the homemaker—designated as that woman member of the family who is responsible for the care of the home and family—pursued a gainful occupation in addition to her household duties. Nearly 4,000,000 homemakers, or one out of seven, were thus employed in 1930, and four-fifths of this number were employed away from home. Over one-half of those employed at home were engaged in agricultural occupations. The largest group of those employed on work away from home were in the service industries (30.4 per cent); the second largest group was classified as "industrial workers" (23.4 per cent); and the third largest as office workers (15.9 per cent).

Gainful Workers by Social-Economic Classes

All gainful workers have been classified in occupation groups which permit distinctions to be made between head workers and hand workers, and which also provide further broad classifications according to mental ability and physical skill. The six main occupation groups shown in Table 3 are arranged, approximately at least, in descending order of the social-economic status of the workers in them.

The most significant changes between 1910 and 1930 in the distribution of the male workers were the decrease in the proportion of the total represented by farmers—from 19.5 per cent to 15.1 per cent—and the decrease in the proportion farm laborers formed of the total, from 15.6 per cent to 9.8 per cent. Since 1910, a greatly increased efficiency in farming operations has been effected by the wide introduction of more scientific farm practices and the widespread use of motor-driven machinery, with the result that fewer workers have been able to produce all the required supply of agricultural commodities.

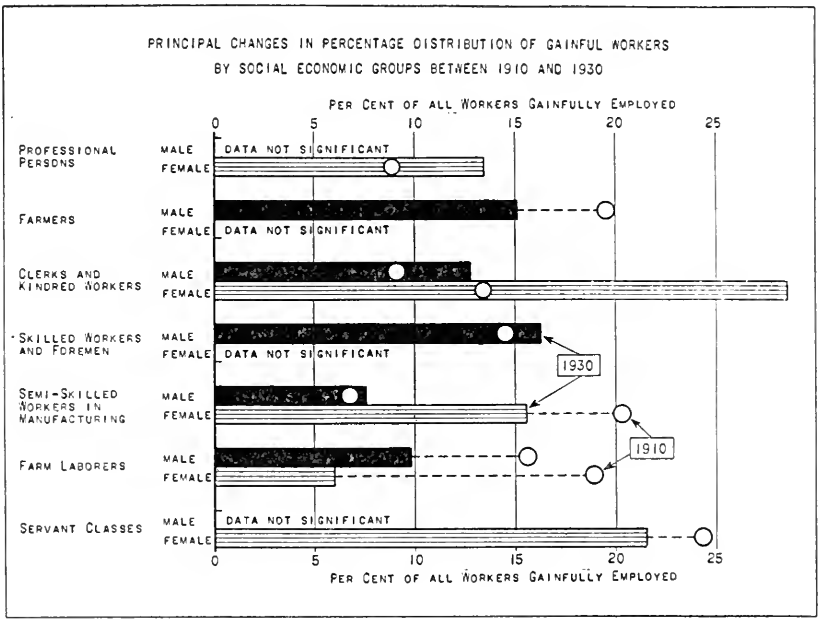
At each census the distribution of female gainful workers by social-economic groups has differed considerably from that of male workers. As compared with the corresponding pro-

TABLE 3. PERCENTAGE DISTRIBUTION OF GAINFUL WORKERS BY SOCIAL-ECONOMIC GROUPS

Group Classification	1930			1920			1910		
	Total	Male	Female	Total	Male	Female	Total	Male	Female
	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
1. Professional Persons....	6.0	3.9	13.5	4.9	3.2	11.6	4.3	3.0	8.9
2. Proprietors, Managers and Officials.........	19.8	24.1	4.7	22.1	26.5	4.9	22.2	26.9	4.9
2*a*. Farmers (owners and tenants)........	12.3	15.1	2.5	15.3	18.5	3.1	16.1	19.5	3.4
2*b*. Wholesale and retail dealers........	3.7	4.4	1.0	3.4	4.0	0.9	3.3	3.9	0.8
2*c*. All other proprietors, etc.................	3.8	4.6	1.2	3.3	4.0	0.9	2.9	3.5	0.7
3. Clerks and Kindred Workers..........	16.3	12.8	28.6	13.7	10.6	25.6	10.0	9.1	13.4
4. Skilled Workers and Foremen..........	12.9	16.3	0.8	13.4	16.5	1.2	11.7	14.5	1.2
5. Semi-skilled Workers...	16.3	14.3	23.5	16.0	13.2	26.5	14.4	11.1	27.1
5*a*. In Manufacturing..	9.3	7.6	15.6	10.5	8.1	19.5	9.6	6.8	20.3
5*b*. Other semi-skilled workers...........	7.0	6.7	7.9	5.5	5.1	7.0	4.8	4.3	6.7
6. Unskilled Workers.....	28.7	28.6	29.0	29.9	29.9	30.2	37.4	35.4	44.5
6*a*. Farm laborers......	9.0	9.8	6.0	10.1	10.2	9.4	16.3	15.6	18.9
6*b*. Factory and building construction laborers............	6.9	8.5	1.2	7.5	9.0	2.0	7.0	8.5	1.1
6*c*. Other laborers.....	6.0	7.5	0.3	6.9	8.6	0.4	7.4	9.3	0.2
6*d*. Servant classes.....	6.8	2.7	21.5	5.4	2.1	18.4	6.7	2.0	24.3

portion for males, the proportion of the females in the professional, clerical, semi-skilled, and servant groups is particularly large and the proportion in the other groups is particularly small. There was a very striking increase between 1910 and 1930 in the proportion of female workers engaged in clerical and kindred pursuits, a marked decrease in the proportion employed as semi-skilled factory workers and as farm laborers, and an appreciable decrease in the proportion employed as servants.

In comparing the social-economic status of the workers in the different population classes in 1930, it was found that a larger percentage of the native whites than of the foreign-born whites was in each of the first three main groups and a much smaller percentage was in each of the last three. The percentage both of native whites and of foreign-born whites was larger than that of negroes in each main group except "unskilled workers," where the percentage was over three times



as large for negroes as for native whites and considerably over twice as high for negroes as for foreign-born whites.

The connection between shifts in the occupational distribution of workers and the rate of population growth may appear to be somewhat obscure, but the relationship is important and the simultaneous changes in both items have been significant. For it is a well-established fact that the occupational composition of the population very decidedly affects the number of children born, as birth rates vary greatly between different occupations. In general, it may be stated that the wives of manual laborers have more children than do those of the white collar workers and that economic success appears to be unfavorable to the raising of large or even medium-sized families. In view of these basic conditions, the census returns show certain changes in the increase and distribution of workers by industries which appear strikingly significant.

As may be observed from Table 3, the proportion of total male workers in the occupational groups which may be classed as mainly in the small family category—professional persons, proprietors (except farmers), managers, and officials, clerks and kindred workers, and skilled workers and foremen—increased from 34 per cent in 1910 to 42 per cent in 1930. During the same time the large family group—composed of farmers, semi-skilled and unskilled workers—declined correspondingly in relative importance from 66 per cent to 58 per cent. Such changes as these are contributing to a slower rate of natural increase.

Conclusion

An examination of the 1930 census figures on gainfully occupied workers discloses the great diversity of occupations in the industrial and business world. Outside of the agriculturalists there is no one great class. The factory workers form a large group, but they are split up into a wide variety of production activities and are subject to many different influences. Moreover, a comparison of the occupational statistics for 1930 with those for 1910 emphasizes the constant and sometimes rapid changes in industrial conditions which open up new employment opportunities to some groups of workers while leaving others stranded, at least temporarily. Thus the discovery or invention of new products may account for the development of new industries, which in turn may adversely affect some occupations that flourished in earlier decades. These occasional dislocations of labor tend to unbalance the distribution of workers by industries, since the characteristic immobility of labor tends to delay the necessary readjustments.

In conclusion, the most striking tendencies indicated by a comparison of the 1930 census data on occupations with the corresponding 1910 figures are: the remarkable expansion of many basic industries, the rapid growth of several new industries, the declining importance of a few trades, the increased significance of women in industry, the drastic reduction in child labor, the enlarged proportion of native whites among total workers, and the increased importance of the white collar occupations. All these changes reflect marked economic and social progress, resulting largely from technological improvements in industry. Furthermore, these developments have a bearing upon the telephone market, both quantitatively and qualitatively, and a consideration of these changes is important to the telephone industry.

R. L. Tomblen

Notes on Recent Occurrences

CONFERENCE OF BELL SYSTEM PUBLIC RELATIONS OFFICIALS

A CONFERENCE of representatives of all Bell System companies, including the Western Electric Company and the Bell Telephone Laboratories, was held at Shawnee-on-the-Delaware, Pennsylvania, September 14–18, 1934, to discuss general matters relating to the System's publicity, advertising, and public relations policies. Vice-president A. W. Page, of the American Telephone and Telegraph Company, presided. Addresses by President W. S. Gifford and Vice-president Bancroft Gherardi of the American Telephone and Telegraph Company were important features of the program. Others of that company who attended the conference included S. L. Andrew, Chief Statistician; Harvey Hoshour, General Solicitor; K. S. McHugh, Commercial Engineer; W. J. O'Connor, Assistant to President; and members of the Information Department.

J. F. BELL ELECTED A DIRECTOR

AT a meeting of the Board of Directors of the American Telephone and Telegraph Company held on September 19, James F. Bell, of Minneapolis, Minnesota, was elected a director to fill the vacancy caused by the resignation of Eugene V. R. Thayer. Mr. Bell is Chairman of the Board of General Mills, Inc.

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